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EXPLANATION

AND

USE

OF THE

ROTADIARIUM;

OR

TWENTY-YEAR ALMANACK.

Being a Work ſuperbly engraved, and calculated to anſwer, in an eminent Degree, all the Purpoſes of an Almanack for twenty Years to come.

By J. HOPPER,
Of the CITY of DURHAM.

NEWCASTLE UPON TYNE:
Printed by HALL and ELLIOT.

MDCCXC.

(*PRICE, FIVE SHILLINGS AND SIX-PENCE.*)

BRITISH MUSEUM

Excluſive of the Twenty-year Almanack, the ROTADIARIUM contains the following uſeful, inſtructive, and entertining Articles, viz.

1ſt. A Table of all the known iſlands in the world, ſhewing what countries they are neareſt to, what ſeas they are in, how far diſtant from England, and what way they lie; with an account of their produce, what kind of articles we import from them, and what we export to them.

2d. A Table of all the chief cities and towns in the world, ſhewing what countries they are in, how far diſtant from England, and what way they lie; with an account of what kinds of wares or merchandize we import from all nations, and what we export to them.

3d. A Table ſhewing the ſpecific gravity of bodies, that is, a Table ſhewing how much one kind of matter is heavier or lighter than any other kind, being of the ſame ſize or bulk; as how much a ſolid inch of gold, &c. is heavier than a ſolid inch of ſilver, or any other kind of matter: how much a ſolid foot of any kind of wood, &c. is heavier or lighter than water, or any other fluid; by which it is known what kind of matter will ſwim, and what will ſink in any kind of fluid; alſo ſhewing the ſolid content of any piece of wood, ſtone, &c. in feet or inches, &c. without the trouble of meaſuring it, and likewiſe its weight, without the trouble of weighing it; with many other uſeful particulars.

4th. A Geographical Clock, ſhewing at one view what o'clock it is at any time in all parts of the world, what longitude every place is in, and how much they differ from one another in the hour of the day or night: as for inſtance, when it is 12 o'clock in the day in England, what o'clock will it be then at Pekin in China, New York in America, and at New Zealand in the great South Sea? The clock ſhews that when it is 12 o'clock in the day in England, it is then near 9 o'clock at night at Pekin in China, 7 o'clock in the morning at New York in America, and near 12 o'clock at night at New Zealand; and in like manner the clock ſhews the time at all other places.

5th. A Tide Clock, ſhewing the true time of high-water at all the ſeaports in England, Scotland, Ireland, France, Spain, Portugal, and Holland, every day in the year.

6th. A true repreſentation of that great and marvellous work, THE SOLAR SYSTEM, ſhewing at one view how all the planets and comets move round the Sun, by what cauſe they move, and how they are kept in perpetual motion round the Sun; alſo their reſpective diſtances from the Sun, and in what time each planet performs its courſe round the Sun, with the number of miles they move in their orbits every hour; likewiſe ſhewing in what time each planet turns round its axis, with their diameters and circumferences in Engliſh miles; their proportion of bulk, quantity of matter, gravity on their ſurfaces, light and heat, &c. all compared with the earth. Alſo ſhewing how the ſatellites or moons of Jupiter and Saturn move round thoſe amazing large planets, and how one or more of them are eclipſed almoſt every day.

Alſo ſhewing how the Moon moves round the earth from change to change, why ſhe ſeems to put on a different ſhape every day, and why ſhe is always inviſible to us at the time of her change; with many other particulars relating to her age, diſtance from the earth, motion, &c.

Alſo a reſpreſentation of eclipſes of the Sun and Moon, ſhewing at one view how they are cauſed, and in what manner they happen; likewiſe ſhewing, in a moſt clear manner, how the earth moves round the Sun, and that the lengthening and ſhortening of the days, the change of the ſeaſons, &c. are cauſed by different parts of the earth being turned towards the Sun at different times of the year, and by what means all theſe things are effected.

Alſo ſhewing how the earth turns round its center or axis every 24 hours, and by that perpetual motion cauſes an alternate ſucceſſion of day and night to all parts of the terraqueous globe; likewiſe ſhewing by what cauſe all things are kept ſecure in their places on all ſides of the earth, and are prevented from falling from the earth while the earth turns round its axis; with many other valuable articles too numerous to mention here.

7th. A full and clear account of the old and new ſtyle, explaining the true cauſe why the ſeaſons, by the old ſtyle account, fell a day later every 130 years, and how this is rectified by the new ſtyle account.

To which are added, ſome infallible rules to know the weather, which being well obſerved, any perſon may know what kind of weather will happen every month throughout the year.

DIRECTIONS

FOR FRAMING THE

ROTADIARIUM.

1ſt. LAY the copy upon a clean table, and wet the back of it well all over with a clean linen cloth, ſteeped in fair water, continuing the wetting till the paper be ſufficiently expanded, (which it will be in about ten minutes.)

2d. Lay the back of the frame upon the copy, ſo that the edges of the back may coincide with the mark which the edge of the plate has made on the paper, and fold the edges of the copy over the edges of the back, paſting them cloſe down with paſte.

3d. Put the copy thus prepared into the frame, and faſten it well down with ſprigs, and when the paper is dry, the copy will brace ſmooth and level like the head of a drum, and conſequently will be free from creaſes or wrinkles.

Note. The back ſhould be ſo well ſeaſoned and dried, that it may not pine and contract after it is put into the frame, otherwiſe it will cauſe the copy to creaſe.

PREFACE.

THE firſt impreſſion of the Rotadiarium has been ſo well received by the public, that upwards of ſeven hundred copies were ſold in leſs than two months after its publication; (in the four northern counties only) and a ſecond edition having been repeatedly called for, the author has, in conſequence thereof, made ſeveral additions and improvements, which he doubts not will meet with approbation.

In order to make the work as uſeful as poſſible, and adapt it to the level of all capacities, the greateſt care has been taken to have it perfectly accurate, and eaſy to be underſtood. That part of the work which anſwers all the purpoſes of an almanack, (for twenty years) is digeſted into tables, and theſe tables are ſo artfully contrived, that every thing contained therein may be found by a ſingle glance of the eye: And as to the geographical, aſtronomical, and other parts of the work, they are explained in ſo clear and intelligible a manner, that any perſon who can but read, and reaſon a little, may readily comprehend them. As young people are apt to imbibe falſe notions, and judge of things only by appearances; this work is therefore particularly recommended to young gentlemen and ladies, as by it they may (without any previous knowledge of geometry or mathematics) eaſily and ſpeedily acquire a competent knowledge of all the motions, ſituations, diſtances, magnitudes, &c. of the ſun, earth, and the reſt of the planets, with the true cauſes of ſummer and winter, ſpring and autumn, day and night, lengthening and ſhortening of the days, and many other uſeful, inſtructive, and entertaining articles, worthy attention, and neceſſary to be known.

A N I N D E X

To find the RULES which explain and ſhew the uſe of every part of the ROTADIARIUM.

Page.
ATTRACTION, what — — — — 36
Autumn, how cauſed — — — — 32
Areas, the planets deſcribe equal areas in equal times 50
Cannon ball, its ſwiftneſs — — — — 28
Comets, what — — — — — — 17
Clock, to find what o'clock it is at any time in any country 11
Day, the cauſe of, why the days lengthen and ſhorten — 34
Day of the month, and day of the week, to find — 4
Diſtance of the planets from the ſun — — — 19
Eclipſes of the ſun and moon viſible — — — 3
Eclipſes, how cauſed — — — — — 38
Feaſts moveable to find — — — — 1
Golden Number to find — — — — 5
Gravity, what, its effects — — — — 35
Iſlands, an account of — — — — 63
Moon, to find when the moon changes or is at full — 3
Moon, to find when the moon riſes or ſets — — 6
Moon, to find the age of the moon — — — 5
Moon, to find what ſign the moon is in at any time — 8
Moon, an account of — — — — — 21
Motion of the planets round the ſun, cauſe of — 47
Night, how cauſed — — — — — 34
Objects appear leſs the farther we are from them — 16
Planets, an account of them — — — 19 & 47
Solar ſyſtem, an account of — — — — 15
Saint days, to find what days of the month they fall on 2
Seaſons, how cauſed — — — — — 31
Spring, how cauſed — — — — — 33
Sundays, to find the name of any Sunday — — 2
Sun, an account of — — — — — 19
Sunday letter to find — — — — — 4
Sun's riſing and ſetting to find — — — 7
Summer, how cauſed — — — — — 28
Stars, an account of — — — — — 42
Style, old and new, why changed, &c. — — 44
Specific gravity of bodies, how found — — 56
Specific gravity of bodies, a table of — — — 52
Tides, to find high water at any place — — 10
Water, to find the time of high water at any ſea-port — 10
Weather, to find what kind of weather will happen — 58
Winter, how cauſed — — — — — 32

EXPLANATION AND USE OF THE ROTADIARIUM.

To find the moveable Feaſts in any year, (by Table VII.)

Example 1ſt. IN the year 1791, when will Septuageſima Sunday fall?

Rule. Under the year of our Lord, in the firſt column, look for 1791, and guide your finger along that line till you come to a column which has the words Septuageſima Sun. at the top, and there you will find Feb. 20th for anſwer: ſo in the year 1791, Septuageſima Sunday will be on the 20th of February.

Example 2d. When will Aſh-Wedneſday fall in the year 1791?

Under Aſh-Wedneſday, and oppoſite the year 1791, you will find March 9th for anſwer.

Ex. 3d. In the year 1792, when will Eaſter Sunday fall?

Under Eaſter Sunday, and on a line with the year 1792, you will find April 8th for anſwer.

Ex. 4th. When will Trinity Sunday fall 20 years hence; namely, in the year 1809?

Under Trinity Sunday, and oppoſite 1809, you will find May 28th for anſwer.

And in like manner the moveable feaſts may be found for any other year in the Table.

To find the name of any Sunday in any year, (by Table VII.)

Ex. 1ſt. In the year 1791, what Sunday will the 16th of January be?

Look for the year 1791 in the firſt column, and run your finger along that line till you come to Jan. 16; then look up to the top of that column, and there you will find the 2d Sunday after Epiphany for anſwer.

Ex. 2d. In the year 1792, what Sunday will the 26th of February be?

Look for the year 1792 in the firſt column, and guide your finger along that line till you come to Feb. 26; then look up to the top of that column, and there you will find the 1ſt Sunday in Lent for anſwer.

Ex. 3d. In the year 1793, what Sunday will fall on the 2d of June?

Look for 1793 in the firſt column, and run your finger along that line till you come to June 2d; then look up to the head of the column, and there you will find 1ſt Sunday after Trinity for anſwer.

Note. The words which ſtand under Epiphany ſhew what day of the week Epiphany falls on every year, and the words under Chriſtmas, ſhew what day of the week Chriſtmas-day falls on each year.

Thus, in the year 1791, the Table ſhews that Epiphany falls on Thurſday, and Chriſtmas-day on Sunday.

To find when any fixed Feſtival, or other remarkable day, falls, (by Table III.)

Rule. Look in the Table for the name of the feſtival or ſaint-day, and directly oppoſite, on the left hand, you will find the day of the month on which that feſtival falls.

Ex. 1*ſt.* When does Valentine-day fall?

Anſwer. February 14.

Ex. 2*d.* When was King Charles the Firſt beheaded?

Anſwer. On the 30th of January.

Ex. 3*d.* When does King George the Third's birthday fall?

Anſwer. On the 4th of June.

Note. The months in this Table are ſeparated from each other by black lines; ſo that it may be ſeen by a ſingle glance of the eye, what holy-days, &c. are in every month.

Note. The days which are marked with the letter R, ſignify red-letter days.

To find when a viſible Eclipſe will happen, (by Table I.)

Rule. Look for the year of our Lord in the firſt column, and directly oppoſite the year you will find the day and hour when an eclipſe will happen.

Note. In this Table, m, ſtands for morning; a, for afternoon; n, for night; and T, for total eclipſe.

Alſo the word Sun, ſignifies an eclipſe of the ſun; and the word Moon ſignifies an eclipſe of the moon.

Thus, in the year 1791, the Table ſhews that there will be two eclipſes; namely, one of the ſun, April 3, at 1 o'clock in the afternoon; and another of the moon, October 12th, at 3 in the morning.

Alſo, in the year 1792, the Table ſhews that there will be only one eclipſe viſible that year; namely, an eclipſe of the ſun, September 16, at 11 o'clock in the forenoon.

To find when a new or full moon will happen, (by Table IV.)

Note. In this Table, N, ſtands for new moon; F, for full moon; m, for morning; a, for afternoon; n, for night; and o, for noon or mid-day.

Ex. When will the moon change in January, in the year 1791?

Under January, and oppoſite the year 1791, you will find N 4: at 4 a, for anſwer, which ſhews that it will be new moon the 4th day, at 4 o'clock in the afternoon.

Ex. 2d. When will the moon be full in February, in the year 1792?

Under February, and on a line with the year 1792, you will find F 8 at 5 m, for anſwer, which ſhews, that it will be full moon the 8th day, at 5 o'clock in the morning.

Ex. 3d. When will the moon change and be at full in March, 20 years hence, that is in the year 1809?

Look for the year 1809, in the firſt column, and guide your finger along that line, till you come to a column, which has March at the top, and there you will find N 16: at 5 m, and F 31 at 4 a, for anſwer, which ſhews, that it will be new moon the 16th day, at 5 o'clock in the morning, and full moon the 31ſt day, at 4 o'clock in the afternoon.

To find what day of the week any day of the month falls on, (by Table VIII.)

Note. In this Table, the firſt column ſhews the year of our Lord from 1789, to 1809, and the ſecond column contains the Sunday letter belonging to each year: The third column, numbered 1, 2, 3, 4, 5, 6, and ſo on, to 31, ſhews the day of the month, and the other ſeven columns contain the names of the days of the week, anſwering to every day of the month.

Ex. 1ſt In the year 1791, what day of the week will the 1ſt of January fall on?

Right againſt 1791, you will find B, the Sunday letter for the year 1791, then look for January at the top of the Table, and guide your finger along that line till you come to the Sunday letter B, then run your finger down the column from B, till you be oppoſite 1, the day of the month, and there you will find Saturday for anſwer.

Ex. 2d. What day of the week will the 4th of April fall on in the year 1793?

The Table ſhews that the Sunday letter for 1793, is F, then look for April, and run your finger along that line till you come to F, then guide your finger down the column from F, till you be oppoſite 4, the day of the month, and there you will find Thurſday for anſwer.

Ex. 3d. In the year 1791, what day of the month will the firſt Thurſday in May fall on?

The Sunday letter for 1791, being B, look for May, and run your finger along that line till you come to B, then guide your finger down the column from B, till you come to the firſt Thurſday in that column, and directly oppoſite that Thurſday you will find 5, the day of the month on which the firſt Thurſday in May falls.

Ex. 4th. In the year 1792, what day of the week will the 1ſt of October fall on?

Note. In this example it muſt be obſerved, that the year 1792, is leap-year, and in every leap-year there are two Sunday letters, that which ſtands firſt, only ſerves for January and February, and then the other takes place and ſerves from that time to the end of the year; therefore in the above example, we muſt make uſe of the latter letter belonging to the year 1792, which is G; having found the Sunday letter for 1792, to be G, look for October, and run your finger along that line till you come to G, then guide your finger down the column from G, till you be oppoſite 1, the day of the month, and there you will find Monday for anſwer.

Ex. 5th. What day of the week will Lady-day or the 25th of March fall on twenty years hence, namely in the year 1809?

The Table ſhews that the Sunday letter for 1809 is A, then look for March, and run your finger along that line, till you come to A, then guide your finger down the column from A, till you be oppoſite 25, and there you will find Saturday for anſwer.

To find the moon's age on any day, (by Table VI.)

Ex. 1ſt. How old will the moon be the 2d of January, 1791.

Look for 1791, in the laſt column but one, and directly againſt that year, under golden No. you will find

6, the golden number for 1791. Then look for January at the top of the Table, and run your finger down that column till you come to 2, the day of the month.—Then guide your finger along the line from 2, till you come to a column which has the golden number 6 at the top, and there you will find 28 days old for anſwer.

Note. The Golden Numbers 1, 2, 3, 4, 5, &c. which ſtand at the top of the Table under G. N°. are in a larger and ſtronger character than the other figures in the Table to diſtinguiſh them from the numbers ſhewing the moon's age.

Note. Alſo that the letters G. N°. ſtand for Golden Number.

Ex. 2d. How old will the moon be the 31ſt of March, 1792?

The Table ſhews that the Golden Number for, 1792, is 7; then look for the 31ſt of March in the firſt column, and guide your finger along that line, till you come under the Golden Number 7, and there you will find 8 the moon's age.

Note. Where you find two different days of the month ſtanding together in the ſame column, thus, 1 : 31, they ſhew that the moon will be the ſame age on each of theſe days.

As in the above example, the Table ſhews that the moon will be 8 days old, both on the 1ſt and 31ſt of March, in the year 1792.

Ex. 3d. How old will the moon be the 30th of May, twenty years hence, namely, in the year 1809?

The Table ſhews that the Golden Number for 1809, is 5.

Then under the Golden Number 5, and oppoſite the 30th of May, you will find 17, the moon's age.

To find when the moon riſes and ſets (by Tables V. and VI.)

Note, In this Table, m ſtands for morning, and n for night.

Ex. 1ſt. At what time will the moon ſet the 7th of February, in the year 1791?

Table VI. ſhews, that the moon will be 4 days old on the 7th of February, 1791. Then in Table V. in the firſt column, look for 7, the moon's age, and guide your finger along that line till you come under February, and there you will find 9 : 57n. which ſhews that the moon will ſet at 57 minutes paſt 9 o'clock at night.

Ex. 2*d.* When will the moon ſet the 22d of December, 1792?

Table VI. ſhews that the moon will be 8 days old on the 22d of December, 1792. Then in Table V. look for 8, the moon's age, and guide your finger along that line, till you come under December, and there you will find 12 : 44 n, which ſhews that the moon will ſet 44 minutes paſt 12 o'clock at night, on the 22d of December, in the year 1792.

Ex. 3*d.* At what o'clock will the moon riſe the 22d of February, in the year 1791?

By Table VI. the moon will be found to be 19 days old. Then in Table V. look for 19, the moon's age, and guide your finger along that line, till you be under February, and then you will find 10 : 20 n, which ſhews that the moon will riſe 20 minutes paſt 10 o'clock at night.

Ex. 4*th.* At what o'clock will the moon riſe, the 4th of March, twenty years hence, namely, in the year, 1809?

By Table VI. the moon will be found to be 19 days old.—Then in Table V. under March, and oppoſite 19, the moon's age, you will find 11 : 10 n. which ſhews that the moon will riſe 10 minutes paſt 11 o'clock at night.

To find the ſun's riſing and ſetting, (by Table IX.)

Ex. At what o'clock will the ſun riſe and ſet on the 5th of March?

Look for March in the firſt column, and run your finger along that line, till you come to a column which has 5 at the top, and there you will find 6 : 28 under the word riſes, and 5 : 32 under the word ſets, which ſhews, that on the 5th of March, the ſun will riſe at 28 minutes paſt 6, and ſet at 32 minutes paſt 5.

Note. In this Table the days of the month ſtand at the top of the columns, above the words riſes, ſets; and, as it is ſufficient for common uſe, to know the time of the ſun's riſing and ſetting to within 3 or 4 minutes, (in order to ſave room) the Table is, therefore, calculated to ſhew the ſun's riſing and ſetting every third day; ſo that when you want to know the time of the ſun's riſing and ſetting on any day of the month, which is not in the Table, you muſt find the ſun's riſing and ſetting for that day which is neareſt the given day.

Thus, when will the ſun riſe and ſet on the 6th of July?

Here the 6th of July is not to be found in the Table, therefore we muſt find the ſun's riſing and ſetting for the 5th of July, which is neareſt to the 6th; and the Table ſhews, that on the 5th of July the ſun will riſe at 40 minutes paſt 3, and ſet at 20 minutes paſt 8.

To find what ſign the moon is in at any time, and what parts of the body are then governed by the moon, (by Tables VI. X. and II.)

Note, The 12 ſigns in the zodiac, which the moon runs through from change to change, are marked and named as follow:

No.	*Marks.*	*Names.*
1	♈	Aries, or the Ram.
2	♉	Taurus, or the Bull.
3	♊	Gemini, or the Twins.
4	♋	Cancer, or the Crab.
5	♌	Leo, or the Lion.
6	♍	Virgo, or the Virgin.

The above are called northern ſigns, becauſe when the moon is in any of theſe ſigns, ſhe is in north latitude.

No.	*Marks.*	*Names.*
7	♎	Libra, or the Balance.
8	♏	Scorpio, or the Scorpion.
9	♐	Sagitarius, or the Archer.
10	♑	Capricornus, or the Goat.
11	♒	Aquarius, or the Waterman.
12	♓	Piſces, or the Fiſhes.

Theſe laſt ſix are called ſouthern ſigns, becauſe when the moon is in any of theſe ſigns, ſhe is in ſouth latitude.

And in order to ſave room, the names of theſe ſigns are contracted thus:—Ari. ſtands for Aries; Tau. for Taurus; Gem. for Gemini; Can. for Cancer; Leo, for Leo; Vir. for Virgo; Lib. for Libra; Scor. for Scorpio; Sag. for Sagitarius; Cap. for Capricorn; Aqu. for Aquarius; and Piſ. for Piſces.

Ex. What ſign will the moon be in the 12th of January, in the year 1791?

By Table VI. the golden number for the year 1791 is 6.—Then, in Table X. look for January, and run your finger down that column, till you come to 12th, the day of the month, then guide your finger along that line till you come to a column which has the golden number 6 at the top, and there you will find Ari. which ſhews that the moon is then in the ſign Aries; and Table II. ſhews, that the parts of the body, which the moon governs when ſhe is in the ſign Aries, are the head and face.

Note. The letters G N° at the top of the Table ſtand for golden number.

Ex. 2d. What ſign will the moon be in the 26th of February, in the year 1792?

Table VI. ſhews that the golden number for 1792 is 7; then in Table X. look for the 26th of February, and run your finger along that line, till you come under the golden number 7, and there you will find Tau. which ſhews that the moon is then in the ſign Taurus; and Table II. ſhews that the parts of the body which the moon governs, when ſhe is in Taurus, are the neck and throat.

Note. When the day of the month cannot be found in the firſt part of Table X. marked A, you muſt look for it in the ſecond part, marked B.

Ex. What ſign will the moon be in the 11th of November, 1793?

Table VI. ſhews that the golden number for 1793 is 8; but the 11th of November cannot be found in the firſt part of Table X. therefore you muſt look for it in the 2d part, marked B. then under the golden number 8, and oppoſite the 11th of November, you will find Aq. which ſhews that the moon is then in the ſign Aquarius; and Table II. ſhews that the parts of the body which the moon governs, when ſhe is in the ſign Aquarius, are the legs and ancles.

Ex. 4th. What ſign will the moon be in the 28th of January, 1794?

Table VI. ſhews that the golden number for 1794 is 9; then, under the golden number 9, and oppoſite the 28th of January, you will find Cap. which ſignifies that the moon is then in the ſign Capricorn.

Note. Where you find two different days of the month ſtanding together in the ſame column, thus, 1:28, or 2:29, &c. they ſhew that the moon will be in the ſame ſign on each of thoſe days.

Note. It is dangerous to geld cattle when the moon is in the ſign Scorpio; therefore this Table ſhould be well obſerved by all thoſe who practiſe the art of caſtration.

To find the time of high water at all the ſea-ports in England, Scotland, Ireland, France, Spain, and Holland, &c. every day in the year, (by the tide clock.)

Rule. Find the moon's age by Table IV. or VI. then always ſet the moon's age, on the inner circle, againſt either the upper or lower XII. on the outer circle, and every place on the clock will ſtand oppoſite its reſpective time of high water, on that day.

Example. What time in the morning will it be high water at London, Briſtol, Hull, and Liverpool, on the 17th of March, 1791?

In Table VI. you will find the moon will be 13 days old on the 17th of March, 1791; then look for 13, the moon's age, (on the inner circle of the tide clock) and ſet that number againſt either the upper or under XII. on the outer circle, and then London will ſtand oppoſite a quarter paſt I.—Briſtol oppoſite a quarter paſt V.—Hull, Lynn, Blackney, and Wells oppoſite a quarter paſt IIII.—and Sandwich, Liverpool, and Millthorp oppoſite three quarters paſt IX. the reſpective times of high water at all thoſe places, in the morning.

Note 1ſt. The outer circle numbered I. II. III. IV. &c. ſhews the hours, and the inner circle numbered 1, 2, 3, 4, 5, 6, &c. to 29, the moon's age; alſo, the mark ☽, ſignifies new moon, that is, when her age is nothing; therefore, when the time of high water at any place is required on the day the moon changes, the mark ☽, muſt be ſet againſt XII.

Note 2d. When the afternoon or evening tide is required, you muſt ſet the moon's age againſt near half an hour after XII.

Ex. 2d. What time in the afternoon will it be high water at Newcaſtle, Berwick, Portſmouth, and Whitehaven on the 28th of June, in the year 1792?

In Table VI. you will find the moon will be 8 days old the 28th of June, 1792; then look for 8 in the inner circle of the tide clock, and ſet that number oppoſite near half paſt XII. then Newcaſtle will ſtand oppoſite a quarter paſt X.—Berwick oppoſite VIII.—Portſmouth and Margate oppoſite near V.—and Whitehaven at a quarter paſt V. the reſpective times of high water in the afternoon at all thoſe places.

To find what o'clock it is at any time in any part of the world, that is, by having the time of day or night in any place to know what o'clock it is then in any other country, (by the geographical clock.)

Rule. Set the name of that place where the time it is known, againſt the given hour, then the name of every place on the clock, will ſtand oppoſite its reſpective time of day or night.

Example 1ſt. When it is 11 o'clock in the morning, in England, what o'clock is it then in New England, in America.

Set England againſt XI. in the morning, then New England will ſtand oppoſite half paſt VI. o'clock in the morning; ſo, when it is 11 o'clock in the morning in England, it is then only half paſt 6 o'clock in the morning in New England.

Ex. 2d. When it is 12 o'clock in the day in England, what o'clock is it then in China?

Set England againſt noon, or XII. o'clock in the day, then China will ſtand oppoſite VIII. o'clock at night; ſo, when it is 12 o'clock in the day in England, it is then 8 o'clock at night in China.

Ex. 3d. When it is half paſt 7 o'clock in the morning at the iſland of Barbadoes, what o'clock is it then in England?

Set Barbadoes againſt half paſt VII. o'clock in the morning, then England will ſtand oppoſite half paſt XI. in the morning; ſo, when it is half paſt 7 o'clock in the morning at the iſland of Barbadoes, it is then half paſt 11 o'clock in the morning in England.

Ex. 4th. When we are dining in England, in what parts of the world are people riſing, where breakfaſting, where ſupping, and where going to bed; allowing the time for riſing to be at half paſt 5 o'clock in the morning, breakfaſting at 8, dining at noon, ſupping at 8 at night, and going to bed at 11.

Set England againſt XII. or noon, then New Spain will ſtand oppoſite half paſt V. o'clock in the morning; Barbadoes, oppoſite near VIII. o'clock in the morning; China, oppoſite near VIII. o'clock at night; and New Zealand, Botany Iſland, &c. oppoſite a little paſt XI. o'clock at night; ſo, when we are dining in England, people are riſing in New Spain, in America; breakfaſting at the iſland of Barbadoes; ſupping in China; and going to bed at New Zealand, Botany Iſland, &c.

Note. That half of the hour-circle marked morning, ſhews the time between XII. o'clock at night and XII. o'clock in the day, and the other half marked afternoon, ſhews the time between XII. o'clock in the day and XII. o'clock at night.

Note. 2d. All the places on that half of the clock marked *eaſt*, are in eaſt longitude, and all the places on that half marked *weſt*, are in weſt longitude: The eaſt half is ſeparated from the *weſt* half by a line paſſing through England and that part marked *ſouth*.

Note. 3d. When the time is known at any place in the afternoon, and the place where the time is required happens to fall beyond or paſt XII. o'clock at night, it ſhews that a new day is begun at that place where the time is required.

Ex. On the 1ſt of May, when it is 10 o'clock at night in England, what o'clock is it then at the iſland of Ceylon, in the Eaſt Indies?

Set England againſt X. o'clock afternoon, that is, X. o'clock at night, then Ceylon will ſtand oppoſite IIII. o'clock in the morning, or 4 hours paſt XII. o'clock at night, which ſhews, that a new day is begun at the iſland of Ceylon: So, on the 1ſt of May, when it is 10 o'clock at night in England, it is then the 2d of May, at 4 o'clock in the morning at the iſland of Ceylon.

Ex. 2d. On the 31ſt of December in any year, ſuppoſe 1791, &c. when it is IX. o'clock at night in England, what o'clock is it then at the Philippian iſlands?

Set England againſt IX. o'clock at night, then the Philippian iſlands will ſtand oppoſite a little paſt V. o'clock in the morning, or V. hours paſt XII. at night, which ſhews, that both a new day and a new year are begun at the Philippian iſlands.

So on the 31ſt of December, in the year 1791, when it is 9 o'clock at night in England, it will then be the 1ſt of January, 1792, at a little paſt V. o'clock in the morning, at the Philippian iſlands.

Note. The difference of time of day or night betwixt one place and another, is cauſed by the earth turning round its center or axis every 24 hours from weſt to eaſt; for as the earth is conſtantly turning round from the weſt towards the eaſt, all places which lie eaſt from us will have noon or mid-day before we have it; becauſe thoſe places will be turned oppoſite to the ſun before that part of the earth where we live is turned oppoſite to him; and on the contrary, all places which lie weſt from us, will have noon after us; becauſe that part of the earth where we live, will be turned towards the ſun, before thoſe places which lie weſt of us, are turned towards him.

The whole circumference of the earth is divided into 360 equal parts, called degrees, and as the earth turns round every 24 hours; if we divide 360 degrees by 24, the quotient will be 15, the number of degrees which anſwer to an hour in time; that is, the earth, in turning round its center from weſt to eaſt, moves 15 degrees every hour:

Conſequently, whether we live in England, or in any other part of the earth, all places which lie 15 degrees eaſt from us, will have noon or mid-day an hour before we have it, that is, when it is 12 o'clock in the day with them, it will only be 11 o'clock in the morning with us; and on the contrary, all places which lie 15 degrees weſt from us, will have noon an hour after us, that is, when it is 12 o'clock in the day with us, it will only be 11 o'clock in the morning with them:

Therefore, the farther any two places lie eaſt or weſt from each other, the greater will be the difference of the time of day or night betwixt thoſe two places.

For inſtance, all places which lie 165 degrees eaſt from us, will have noon 11 hours before we have it, that is, when it is noon with them, it will only be 1 o'clock in the morning with us; and on the contrary, all places which lie 165 degrees weſt from us, will have noon 11 hours after us, that is, when it is 12 o'clock in the day with us, it will only be 1 o'clock in the morning with them.

Hence may be ſeen the reaſon why, if a perſon travel eaſtward round the earth, he will, at his return to the place where he ſet out, have gained a day in his reckoning the time; but if he goes weſtward round the earth, he will loſe a day in his account: This is proved to be true by all perſons who have ſailed round the world, and the reaſon is very evident; for, if we travel eaſtward round the earth, we go the ſame way the earth turns round; and conſequently will gain time, namely, one hour for every 15 degrees we travel; but if we travel weſtward, we go contrary to the motion of the earth, and therefore muſt loſe time, namely, one hour for every 15 degrees we travel.

OF THE SOLAR SYSTEM.

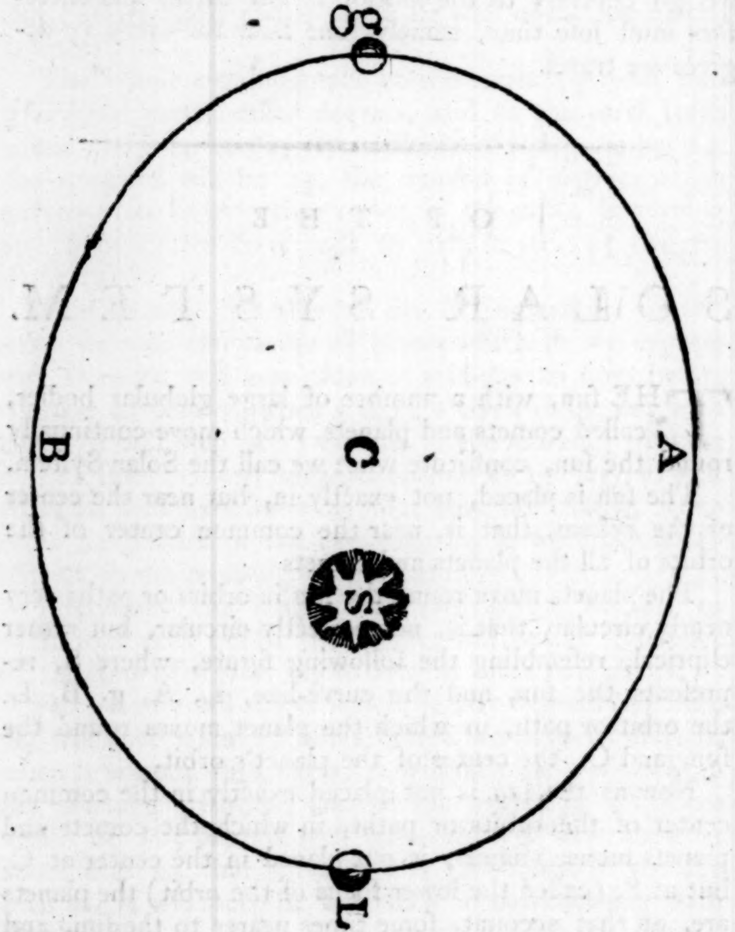
THE ſun, with a number of large globular bodies, called comets and planets, which move continually round the ſun, conſtitute what we call the Solar Syſtem.

The ſun is placed, not exactly in, but near the center of the ſyſtem, that is, near the common center of the orbits of all the planets and comets.

The planets move round the ſun in orbits or paths very nearly circular, that is, not perfectly circular, but rather eliptical, reſembling the following figure, where S, repreſents the ſun, and the curve-line, L, A, g, B, L. the orbit or path, in which the planet moves round the ſun, and C, the center of the planet's orbit.

Now as the ſun is not placed exactly in the common center of the orbits or paths, in which the comets and planets move, namely, is not placed in the center at C, but at S, (called the lower focus of the orbit) the planets are, on that account, ſome times nearer to the ſun, and ſometimes farther from him at different ſeaſons.

Thus; when the planet is in that part of its orbit marked L, it is much nearer the ſun, than when it is in that part marked g: And as all objects appear larger the nearer we are to them, and leſs the farther we are from them, it has been found by a multitude of obſervations, that our earth is nearer the ſun in winter than in ſummer: For the ſun appears conſiderably larger about the ſhorteſt day in winter, than he does about the longeſt day in ſummer, which clearly proves that we are nearer the ſun in winter than in ſummer.



Now as the earth is nearer the ſun in our winter than in our ſummer, one would naturally expect that the
weather

weather ſhould be warmer; but the reaſon why it is not, will appear very evident when we come to explain all the motions and different poſitions of the earth, during its courſe round the ſun, with the cauſe of the lengthening and ſhortening of the days, change of ſeaſons, &c.

Of the COMETS.

The comets move round the ſun in orbits or paths quite different from the planets. For, as we have already obſerved, the planets move round the ſun in orbits very nearly circular; but the orbits of ſome of the comets are ſo eliptical, that the comets are many millions of miles, farther from the ſun at one time than at another.

The great comet which appeared in the year of our Lord, 1680, is 575 years in performing its courſe round the ſun, and the orbit or path it moves in is ſo eliptical, that this comet, when, at its greateſt diſtance, is eleven thouſand two hundred millions of miles from the ſun. And when at its leaſt diſtance, it approaches within ſeventeen thouſand miles of the ſun.

The incomparable Sir Iſaac Newton, calculated the heat of this comet, when at its leaſt diſtance from the ſun, to be two thouſand times hotter than red-hot iron; and that ſo immenſely large a body as this comet is, being thus heated, cannot be quite cooled again during the time of its whole courſe round the ſun.

It is generally believed, by the moſt learned aſtronomers, that there are at leaſt 21 comets belonging to our ſolar ſyſtem, moving continually round the ſun in various directions, and in different periods of time: but the periods of only three of them are yet known, with any degree of certainty. The firſt of which has been obſerved to appear in the years of our Lord 1531, 1607, 1682, and 1758, and as this comet moves round the ſun, in about 75 years, it will very probably appear again in the year 1833.

The ſecond has been obſerved to appear in the years 1532, and 1661 and may be expected to be ſeen again about the beginning of the year 1791.

And the third is the great comet already mentioned, which made its two laſt appearances in the years 1105, and 1680, and may be expected to return again in 2255.

The comets being ſeldom ſeen, by reaſon of their immenſe diſtance from the ſun during the greateſt part of their periods, and their ſtay but very ſhort while they are viſible to us, on account of the amazing quickneſs of their motion when near the ſun, that it could never yet be diſcovered what kind of matter they are made of. All that we know of them, is, that they are ſolid globular bodies, of a much greater denſity than our earth; for ſome of them are heated, every time they come near the ſun, to ſuch a degree, as would vitrify any ſubſtance known to us.

About 30 comets have been obſerved to appear ſince the year of our Lord 1337, but no two appearances ſeem to belong to the ſame comet, except the three above-mentioned: ſo that, very probably, ſome of the comets are above a thouſand years in performing their courſe round the ſun.

As a comet never appears to have a tail but when it is near the ſun; it is generally thought, that the great ſplendour and length of the tail, ariſes from the heat which the ſun communicates to the comet, for when the comet is heated to a great degree, there will naturally riſe a hot vapour into the atmoſphere of the comet, in the ſame manner as ſmoke ariſes from a fire, and as the vapour will always aſcend towards that part of the heavens, which, in reſpect to the comet, is oppoſite to the ſun, the tail of the comet will be directed the ſame way, as we ſee it always is.

Of the SUN *and* PLANETS.

The number of planets which are known to move continually round the ſun are ſeven; their names (reckoning them in their order from the ſun) are, 1ſt, Mercury—2d, Venus—3d, our Earth—4th, Mars—5th, Jupiter—6th, Saturn—and 7th, a Planet, lately diſcovered, called the Georgium Sidus, or the Georgian planet.

Of the SUN.

The ſun is an immenſe globe of fire, placed, as we have before obſerved, near the center of the orbits of all the comets and planets, and turns continually round his center or axis, once in every 25 days, 6 hours, as is evident by the motion of the ſpots ſeen on his ſurface; for theſe ſpots appear firſt on the eaſtern margin or ſide, and gradually move from thence acroſs him, till they diſappear on the weſtern ſide; and in the ſpace of 25 days and 6 hours, they appear again on the eaſtern ſide, and ſo on continually. The diameter of the ſun is computed to be near eight hundred thouſand miles, and his circumference about two millions five hundred thouſand miles; his whole ſurface is about one billion, eight hundred and twenty-eight thouſand, nine hundred and eleven million of ſquare miles; and his ſolidity two hundred and thirty-two thouſand, five hundred and ſeventy-ſeven billions, one hundred and fifteen thouſand, one hundred and thirty-ſeven millions of cubic or ſolid miles.

Of MERCURY.

Mercury is the neareſt planet to the ſun, and moves round the ſun every 87 days 23 hours, conſequently the length of a year, to the inhabitants of Mercury, is only a quarter as long as our year. The diſtance of Mercury from the ſun is thirty-two millions of miles; its diameter two thouſand ſix hundred miles, and its circumference eight thouſand one hundred and ſeventy-one miles; it moves in its orbit round the ſun at the rate of ninety-five thouſand miles every hour: the light and heat it receives from the ſun is almoſt ſeven times greater than the light and heat on our earth; and the ſun appears almoſt ſeven times larger to the inhabitants of this planet than he does to us.

As this planet is ſeldom ſeen, on account of its nearneſs to the ſun, and no ſpots appearing on its ſurface or diſk, the time in which it turns round its center or axis, and the length of the days and nights upon it are not yet known; neither is the gravity on its ſurface known: its ſize or bulk is about one-twenty-ſeventh part of the ſize of our earth, that is, our earth is twenty-ſeven times bigger than the planet Mercury.

Of VENUS.

Venus is the ſecond planet from the ſun, and moves round the ſun every 224 days 17 hours; conſequently the length of a year, to the inhabitants of Venus, is only about 8 of our months.

The diſtance of Venus from the ſun is fifty-nine millions of miles: its diameter ſeven thouſand nine hundred and ſix miles; and its circumference twenty-four thouſand eight hundred and forty-ſeven miles. It moves in its orbit round the ſun, at the rate of ſixty-nine thouſand miles every hour, and turns round its center or axis every 24 days 8 hours; conſequently every day on the planet Venus is ſomething longer than 24 of our days. The light and heat it receives from the ſun, are nearly twice as great as the light and heat on our earth, and the ſun appears nearly twice as large to the inhabitants of Venus as he appears to us; the gravity on its ſurface is not known. Its ſize or bulk is nearly equal to our earth.

When this planet appears weſt of the ſun, it riſes before the ſun in the morning, and is then vulgarly called the morning ſtar; when it appears eaſt of the ſun, it ſhines in the evening after the ſun ſets, and is then called the evening ſtar.

Of the EARTH.

The earth on which we live, is the third planet from the ſun, and moves round the ſun every 365 days 5 hours and 49 minutes, which time, is the true length of our year.

Its diſtance from the ſun is eighty-two millions of miles. It moves in its orbit round the ſun at the rate of fifty-eight thouſand miles every hour, and turns continually round its center or axis from weſt to eaſt every 24 hours, and by that perpetual motion cauſes an alternate ſucceſſion of day and night to all parts of the globe, as will be ſhewn farther on, when we come to explain the true cauſes of day and night, and the change of ſeaſons, &c. Its diameter is ſeven thouſand nine hundred and ſeventy miles, and its circumference twenty-five thouſand and forty-eight miles.

The whole ſurface of the earth contains about two hundred millions of ſquare miles. Europe contains five millions of ſquare miles, Aſia eleven millions, Africa ten millions, America fourteen millions, and the ſea and uninhabited parts about the north and ſouth poles, one hundred and ſixty millions.

It is found, by the moſt exact calculation, that three-fourths of the whole ſurface of the earth are covered with water, and only one-fourth part of it dry land.

Although the earth actually meaſures twenty-five thouſand and forty-eight miles round about; its ſize or bulk is only about a nine hundredth thouſandth part the ſize of the ſun, that is, the ſun is nine hundred thouſand times bigger than our earth.

Of the MOON.

The moon is not a planet, but a ſatellite, or attendant on the earth; ſhe moves round the earth every 27 days, 7 hours, 43 minutes, and is carried along with the earth round the ſun every year. Her diſtance from the earth is two hundred and forty thouſand miles, and ſhe moves in her orbit round the earth at the rate of two thouſand three hundred miles every hour. Her diameter is two thouſand one hundred and eighty miles, and her circumference ſix thouſand eight hundred and fifty-one miles. She turns round her center or axis in the ſame time that ſhe moves round the earth, namely, in 27 days, 7 hours, 43 minutes, and, by that means, we always ſee the ſame ſide of her, for her motion round her axis turns juſt as much of her to us, as her motion round the earth turns from us.

Although the ſame ſide or face of the moon be ſtill turned towards us, yet it is not always viſible, but daily ſeems to put on different appearances; for the moon being a dark body, like our earth, only ſhines by reflecting the light of the ſun; therefore, when the ſun does not ſhine on that ſide of the moon, which is next or oppoſite to the earth, ſhe becomes inviſible; this always happens at the time of new moon or change, when the moon comes in betwixt us and the ſun; for, at that time, the ſun ſhines on the oppoſite ſide of the moon, and the ſide which is next to us is all in darkneſs, and therefore becomes inviſible. (See the ſolar ſyſtem.)—— But when the moon has advanced a little way forward in her orbit from the place of her change, marked 1, to that part of her orbit marked 3, (being then about three days old) a ſmall part of that ſide of her which is oppoſite the earth, is turned towards the ſun, and then we ſee a ſmall portion of her weſtern ſide enlightened, which is her firſt appearance after her change. As ſhe continues to move forward, there is every day more and more of that ſide of her which is next the earth, turned towards the ſun, and, by that means, we ſee more and more of her enlightened, till ſhe comes to that part of her orbit marked 7, when ſhe is about 7 days old, and then half of that ſide of her which is oppoſite to us, is turned towards the ſun, and we ſee half of her enlightened. As ſhe ſtill proceeds forward, there is every day more and more of that ſide of her which is next to us, turned towards the ſun, and by that means we ſee more and more of her enlightened till ſhe comes to that part of her orbit marked 15, when ſhe is about 15 days old, and then all that ſide which is next to us, is turned directly oppoſite the ſun, and ſhe appears with a round enlightened face, which we call the full moon.

Now, when the moon is at her full, ſhe begins to put on a different appearance, every day, to what ſhe had before; for all the time ſhe is moving through that half of her orbit marked 1, 3, 7, 11, 15, namely, from her change to her full, there is, every day, more and more of that ſide which is next to us, turned towards the ſun, and we ſee more and more of her enlightened; but, after her full, there is, every day, leſs and leſs of that ſide of her which is next to us turned towards the ſun, and we ſee leſs and leſs of her enlightened all the time ſhe is moving through the other half of her orbit, marked 15, 18, 22, 26, 1, namely, from her full to her change again; and then ſhe gets in betwixt us and the ſun, and becomes inviſible as before. And in this manner the moon moves continually round the earth from change to change; and all the while ſhe is moving round the earth, ſhe is, at the ſame time, going along with the earth round the ſun, and alſo turning continually round her own center or axis; ſo that the moon has three perpetual motions, namely, a motion round the earth, a motion round the ſun, and a motion round her own center or axis.

Note. By looking at the moon through a good teleſcope, we perceive long tracts of prodigious high mountains ranged one behind another, ſome of which appear to be at leaſt 12 miles high.

Thoſe dark places which appear on the face of the moon, and which formerly were thought to be ſeas, are now found to be vaſt deep vallies, or cavities, that do not reflect the light of the ſun ſo ſtrongly as others, having many caverns and pits, whoſe ſhadows fall within them, and are always dark on the ſides next the ſun, which proves them to be hollow; and moſt of theſe pits have little knobs, like hillocks, ſtanding within them, which caſt ſhadows alſo, and cauſe thoſe places to appear darker than others which have fewer and leſs remarkable caverns.

Hence we ſee the true cauſe of thoſe dark places which appear on the face of the moon.

By ſome new improvements in the teleſcope, whereby the face of the moon is now more diſtinctly and clearly ſeen, there have of late been burning mountains obſerved in the moon, which prove that the moon is made of the ſame kind of matter as our earth; and, in all probability, is inhabited with people, and other creatures, in the ſame manner as our earth is.

Of MARS.

Mars is the fourth planet from the ſun, and moves round the ſun every 686 days 23 hours, conſequently the length of a year to the inhabitants of Mars, is almoſt as long as two of our years.

The diſtance of this planet from the ſun is one hundred and twenty-five millions of miles. It moves in its orbit round the ſun, at the rate of forty-ſeven thouſand miles every hour. Its diameter is four thouſand four hundred and forty-four miles; and its circumference thirteen thouſand nine hundred and ſixty-nine miles. It turns round its center or axis every 24 hours 40 minutes; conſequently every day on the planet Mars is 40 minutes longer than one of our days. The light and heat which this planet receives from the ſun, are only about half the light and heat on our earth; and the ſun appears almoſt twice as big to us as he does to the inhabitants of Mars. The ſize of this planet is only a fifth part ſo big as our earth, that is, our earth is five times bigger than Mars. The gravity on its ſurface is not known.

Of JUPITER.

Jupiter is the fifth planet from the ſun, and moves round the ſun every 11 years, 314 days, 12 hours, conſequently every year to the inhabitants of Jupiter is almoſt as long as 12 of our years.

The diſtance of this planet from the ſun is four hundred and twenty-ſix millions of miles. It moves in its orbit round the ſun at the rate of twenty-five thouſand miles every hour: Its diameter is eighty-one thouſand miles, and its circumference two hundred and fifty-four thouſand ſix hundred miles. It turns round its center or axis every 9 hours, 56 minutes, conſequently, the days and nights on the planet Jupiter, are not half ſo long as our days and nights. The light and heat which this planet receives from the ſun, are only the twenty-eighth part of what our earth receives, that is, we receive twenty-eight times more light and heat from the ſun than the planet Jupiter, and the ſun appears twenty-eight times bigger to us than he does to the inhabitants of Jupiter. This amazingly large planet is a thouſand times bigger than our earth, and the gravity on its ſurface is twice as great as the gravity on our earth, that is, any kind of matter that weighs 10 pounds here, on our earth, would weigh 20 pounds on the planet Jupiter.

The planet Jupiter is attended by 4 ſatellites or moons, moving continually round it. Theſe moons afford a conſtant light to this planet, for there is ſcarce any part of it but what is enlightened by one or more of theſe moons every night.

The orbits of theſe moons (ſee the ſolar ſyſtem) are repreſented by four ſmall circles, marked 1, 2, 3, 4. The firſt moon moves round Jupiter in 1 day, 18 hours, 36 minutes, and is two hundred and twenty-nine thouſand miles diſtant from Jupiter; the ſecond moon goes round Jupiter in 3 days, 13 hours, 15 minutes, at the diſtance of three hundred and ſixty-four thouſand miles; the third performs its courſe round Jupiter in 7 days, 3 hours, 59 minutes, at the diſtance of five hundred and eighty thouſand miles; and the fourth, which is the fartheſt from Jupiter, performs its revolution in 16 days, 18 hours, 30 minutes, at the diſtance of one million of miles.

By calculating for the meridian of London, the exact times when the eclipſes of Jupiter will happen, the longitude of places may be found with greater certainty than by any other method yet diſcovered; for inſtance, ſuppoſe we are in a certain place of the world where we want to know the longitude, and obſerve the beginning or ending of one of theſe eclipſes to be at 9 o'clock in the morning, and by looking into the calculations for London, we find the ſame eclipſe will happen at 10 o'clock that morning at London, the difference betwixt theſe times being 1 hour, anſwers to 15 degrees, and as the eclipſe happens ſooner at the place we are in, than in London, it ſhews, that we are in 15 degrees of weſt longitude from London; but if this eclipſe had happened one hour later than at London, we would then have been in 15 degrees eaſt longitude from London.

Jupiter is ſurrounded by faint ſubſtances, called belts; theſe belts are generally thought to be nothing but clouds hovering round that planet; for ſome of them appear, firſt interrupted and broken, and then vaniſh quite out of ſight, at other times they appear of different breadths, and afterwards become all of the ſame breadth. Some times there is an appearance of large ſpots in thoſe belts, and when a belt vaniſhes, the ſpots diſappear with it.

Of SATURN.

Saturn is the ſixth planet from the ſun, and moves round the ſun in 29 years, 167 days, 5 hours, conſequently, every year to the inhabitants of Saturn, is almoſt as long as 30 of our years.

The diſtance of this planet from the ſun is ſeven hundred and eighty millions of miles, and it moves in its orbit round the ſun at the rate of eighteen thouſand miles every hour.

Its diameter is ſixty-ſeven thouſand miles, and its circumference two hundred and ten thouſand ſix hundred miles.

This planet having no viſible ſpots on its ſurface, whereby to determine the time in which it turns round its center or axis, the length of the days and nights upon it has never yet been diſcovered.

The light and heat this planet receives from the ſun are only a ninetieth part of what our earth receives, that is, we receive ninety times more light and heat from the ſun than the inhabitants of Saturn. This planet is ſix hundred times bigger than our earth, and the gravity on its ſurface is about one and a half times greater than on our earth, that is, any kind of matter which weighs a pound upon our earth, will weigh a pound and an half on the planet Saturn.

This planet is attended by five ſatellites, or moons, moving continually round it; the orbits of theſe moons are repreſented in the ſcheme of the ſolar ſyſtem (ſee the figure) by five ſmall circles, marked 1, 2, 3, 4, 5, the firſt, or neareſt moon, moves round Saturn in 1 day, 21 hours, 19 minutes, and is diſtant from Saturn one hundred and forty thouſand miles; the ſecond moon goes round Saturn in 2 days, 17 hours, 40 minutes, at the diſtance of one hundred and eighty-ſeven thouſand miles; the third moves round Saturn in 4 days, 12 hours, 25 minutes, at the diſtance of two hundred and ſixty-three thouſand miles; the fourth goes round Saturn in 15 days, 22 hours, 41 minutes, at the diſtance of ſix hundred thouſand miles; and the fifth, or outermoſt moon, moves round Saturn in 79 days, 7 hours, 48 minutes, and is diſtant from Saturn one million eight hundred thouſand miles.

Saturn is ſurrounded with a bright and luminous ſubſtance, called a ring; this ring is about twenty thouſand miles in breadth, and affords a continual light to the planet; ſo that although Saturn receives only a ſmall portion of light from the ſun, that defect is abundantly compenſated by the light of the ring and the five moons which move continually round that planet.

The GEORGIUM SIDUS

Is the next planet from the ſun, but, as it is ſituated beyond Saturn, it could not be inſerted in the ſcheme of the ſolar ſyſtem for want of room.

By taking a retroſpective view of the motions of the planets round the ſun, it may be obſerved that thoſe planets which are neareſt the ſun move much quicker in their orbits than thoſe which are farther from the ſun; for inſtance,

Mercury, the neareſt planet to the ſun, moves 95 thouſand miles an hour.

Venus, the 2d planet from the ſun, moves 69 thouſand miles an hour.

Our Earth, the 3d planet from the ſun, moves 58 thouſand miles an hour.

Mars, the 4th planet from the ſun, moves 47 thouſand miles an hour.

Jupiter, the 5th planet from the ſun, moves 25 thouſand miles an hour.

Saturn, the 6th planet from the ſun, moves 18 thouſand miles an hour.

This difference in the ſwiftneſs of the motions of the planets round the ſun, is cauſed by the ſun's attraction, for thoſe planets which are neareſt the ſun, are moſt attracted by the ſun, and on that account are cauſed to move ſwifter in their orbits than thoſe which are farther from the ſun; as will be ſhewn farther on, when we come to explain the laws by which the planets are kept in perpetual motion round the ſun.

In order to form ſome idea of the diſtance of the planets from the ſun, it may be proper here to obſerve, that if a cannon ball was ſhot from the ſun, and to continue flying with unabated force, it would fly to the planet Mercury in about 7 years and 223 days.

To Venus, in about 13 years and 76 days.
To our Earth, in about 19 years and 183 days.
To Mars, in about 29 years and 175 days.
To Jupiter, in about 101 years and 114 days.
To Saturn, in about 185 years and 183 days.

And to the neareſt of the fixed ſtars, in 7 millions and 600 thouſand years.

Note. A ball ſhot out of a cannon flies at the rate of about 8 miles in a minute, or 480 miles every hour.

An explanation of the true cauſes of Summer and Winter, Spring and Autumn, lengthening and ſhortening of the Days, &c.

We have already obſerved, that the earth moves round the ſun in 365 days, 5 hours, 49 minutes, which is the true length of our year. This motion of the earth, round the ſun, every year, is called its annual or periodical revolution, and all the time the earth is performing its courſe round the ſun, it alſo turns continually round its center or axis every 24 hours. This motion of the earth round its center or axis, is called its diurnal or daily motion; becauſe, by this motion we have an alternate ſucceſſion of day and night; for, when that ſide of the earth on which we live is turned towards the ſun, we have day; and when it is turned from the ſun, we have night.

The path in which the earth, or any other planet, moves round the ſun, is called its orbit; but the earth's path is commonly called the ecliptic, becauſe eclipſes always happen there, namely, where the moon's orbit croſſes or interſects the earth's orbit.

In order to diſtinguiſh one part of the earth from another, and to aſſiſt the imagination in forming a clear idea of all the motions and poſitions of the earth, while it is performing its courſe round the ſun, it will be neceſſary to conceive or ſuppoſe certain lines and circles drawn upon it. Thus, the line or circle EQ, (ſee the repreſentation of the ſolar ſyſtem) is a great circle going round the middle of the earth, and cuts or divides the earth into two halves or hemiſpheres, the one called the northern hemiſphere, and the other the ſouthern. This line or circle EQ, is called the equator, or equinoctial, becauſe when the earth is in thoſe two points of its orbit, marked ſpring and autumn, the ſun's rays do then fall perpendicularly upon the equator, and by that means cauſe the days and nights to be equal over all parts of the earth, as will be more fully explained farther on.

The line marked S N, is a line conceived to paſs thro' the center or middle of the earth, and is called the axis of the earth, becauſe on this axis the earth turns round every 24 hours. That end of the axis marked N, is the north pole of the earth; and the other end marked S, the ſouth pole of the earth; and theſe ends of the axis never ſhift their poſition, but always point the ſame way, that is, they always point to the ſame place in the heavens during the earth's whole courſe round the ſun; and, by this means, the ſame parts of the earth are more turned towards the ſun at one time of the year, than another, and conſequently cauſes the weather to be warmer at one ſeaſon than another: for inſtance, in our own country, when that part of the earth on which we live, is moſt turned towards the ſun, (which happens about the 21ſt of June, when the earth is in that part of its orbit marked ſummer) we have our longeſt days and warmeſt weather; becauſe the rays of the ſun do then fall more perpendicularly and copiouſly upon us than at any other time of the year. And when that part of the earth, on which we live, is moſt turned from the ſun, which happens about the 21ſt of December, when the earth is in that part of its orbit (marked winter), we have our ſhorteſt days and coldeſt weather, becauſe the ſun's rays do then fall more obliquely and leſs copiouſly upon us than at any other ſeaſon in the year.

It is to be obſerved, that if the plane of the ecliptic, that is, the plane of the earth's path round the ſun, had coincided with the plane of the equator, and the axis of the earth had ſtood perpendicular to it, that part of the earth where the equator goes round, would always have been directly oppoſite the ſun, and the ſun's rays would always have fallen perpendicularly upon the equator, and we ſhould then have had no change of ſeaſons, nor lengthening or ſhortening of days, but conſtantly equal day and night throughout the year. But this is far from being the caſe, for it is well known to every one that we have a continual change of ſeaſons, and lengthening and ſhortening of the days; but there are very few people (comparatively ſpeaking) that know the true and real cauſe of theſe viciſſitudes.

Now in order to have a clear idea and comprehenſive knowledge of the true cauſes of all theſe viciſſitudes, it muſt be obſerved, that the change of ſeaſons, and lengthening and ſhortening of the days are cauſed by the axis of the earth, not being perpendicular to the plane of the ecliptic, but inclined to it in an angle of 23 degrees and an half; and as the axis always points the ſame way, that is, conſtantly to one part or point in the heavens, as we have before obſerved, the ſun, by this means, for half a year together, enlightens more of the northern half of the earth than the ſouthern half, becauſe the northern half of the earth is then more turned towards the ſun than the ſouthern half; and during that time, we who live on the northern half of the earth, have our ſpring and ſummer, and they who inhabit the ſouthern half of the earth have their autumn and winter. And during the other half of the year, the ſun enlightens more of the ſouthern half of the earth than the northern half, becauſe the ſouthern half of the earth is then more turned towards the ſun than the northern half, and therefore, during this other half of the year, they who live on the ſouthern half of the earth have their ſpring and ſummer, and we, who inhabit the northern half, have our autumn and winter, conſequently, when we who live on the northern half of the earth have ſummer, they who inhabit the ſouthern half have winter, and when we have winter they have ſummer; alſo, when we have ſpring they have autumn or back end of the year, and when we have autumn they have ſpring.

Now all theſe things will appear very clear and intelligible by taking a view of the repreſentation of the ſolar ſyſtem. The earth is there repreſented in 8 different parts of its orbit, 4 of which are marked with the words, ſpring, ſummer, autumn, and winter.

When the earth is in that part of its orbit, marked ſummer, which it arrives at about the 21ſt of June, the ſun then enlightens more of the northern half of the earth than the ſouthern half, becauſe, at that time, there is more of the northern half of the earth turned towards the ſun than the ſouthern half; for you may perceive, that the north pole of the earth, marked N, is then all in the light of the ſun, and the ſouth pole, marked S, all in darkneſs.

Now while the earth is in this part of its orbit, marked ſummer, we who live on the northern half of the earth, have ſummer or longeſt days, and they who inhabit the ſouthern half, have winter or ſhorteſt days.

While the earth is moving from that part of its orbit, marked ſummer, to that part marked autumn, the ſun enlightens, every day, leſs and leſs of the northern half of the earth, and more and more of the ſouthern half, becauſe during that time, there is, every day, leſs and leſs of the northern half of the earth turned towards the ſun, and more and more of the ſouthern half; conſequently, while the earth is paſſing through this quarter of its orbit, we, who live on the northern half of the earth have our days decreaſing or ſhortening, and they who inhabit the ſouthern half, have their days increaſing or lengthening.

When the earth comes to that part of its orbit marked autumn, (which it arrives at about the 23d of September) its axis is then neither inclined to nor from the ſun, but lies ſideways to him, and then the ſun's rays fall perpendicularly upon the equator and cauſe the days and nights to be equal over all parts of the earth; for, while the earth is in this part of its orbit, the ſun enlightens every part of the earth alike, and for the ſame length of time, namely, for 12 hours together, except at the two poles of the earth, where it is then all day and no night, for the ſun at that time is ſeen all round the horizon in thoſe places.

While the earth is moving from that part of its orbit marked autumn, to that part marked winter (where it comes to about the 21ſt December) the ſun ſtill continues to enlighten leſs and leſs of the northern half of the earth, and more and more of the ſouthern half; becauſe, during the time the earth is moving through that part of its orbit, there is every day leſs and leſs of the north half of the earth turned towards the ſun, and more and more of the ſouthern half, conſequently, while the earth is paſſing through this part of this orbit, we, who live on the northern half of the earth have our days ſtill growing ſhorter and ſhorter, and they who inhabit the ſouthern half have their days growing longer and longer.

When the earth arrives at that part of its orbit marked winter (which it comes to about the 21ſt of December) the north pole of the earth marked N, is then all in darkneſs, and the ſouth pole marked S, is all in the light, the very contrary to what it was when the earth was in that part of its orbit marked ſummer, for there is now (ſee the repreſentation of the ſolar ſyſtem).

juſt as much of the northern half of the earth turned from the ſun, as was then turned towards him. Now when the earth is in this part of its orbit, we, who live on the northern half of the earth, have winter or ſhorteſt days, and they who inhabit the ſouthern half have ſummer or longeſt days.

While the earth is moving from that part of its orbit marked winter, to that part marked ſpring, our days take a different turn; for the ſun, then, begins to enlighten every day, more and more of the northen half of the earth, and leſs and leſs of the ſouthern half, becauſe during that time, there is, every day, more and more of the northern half of the earth turned towards the ſun, and leſs and leſs of the ſouthern half. Therefore, while the earth is moving from that part of its orbit marked winter, to that part marked ſpring, we, who live on the northern half of the earth have our days lengthening, and they who inhabit the ſouthern half have their days ſhortening.

When the earth comes to that part of its orbit marked ſpring (which it arrives at about the 21ſt of March, when the ſpring quarter begins) its axis neither inclines to nor from the ſun, but lies ſideways to him, and then the ſun's rays fall perpendicularly upon the equator, and cauſe the days and nights to be equal over all parts of the earth; the ſame as they were about the 23d of September, when the earth was in that part of its orbit marked autumn.

While the earth is moving from that part of its orbit marked ſpring, to that part marked ſummer, the ſun ſtill continues to enlighten more and more of the northern half of the earth, and leſs and leſs of the ſouthern half, becauſe during that time, there is every day more and more of the northern half of the earth turned towards the ſun, and leſs and leſs of the ſouthern half; therefore, while the earth is paſſing through this part of its orbit, we, who live on the northern half of the earth have our days ſtill growing longer and longer, and they who inhabit the ſouthern half have their days growing ſhorter and ſhorter.

Now when the earth arrives again at that part of its orbit marked ſummer, (where it began) it has then finiſhed a complete period or revolution round the ſun, and immediately begins a new one, and then all the days and ſeaſons proceed, and return again, in the ſame order as before, and ſo on continually.

An explanation of the true cauſe of day and night.

Having already obſerved that day and night are cauſed by the earth turning round its center or axis, every 24 hours; we are in the next place to ſhew how this great work is effected.

Now in order to form a clear idea of this matter, it muſt be underſtood that the earth being round like a globe or ball, the ſun can never enlighten more than half of it at once; therefore, one half of the earth is always in the light, and the other half in darkneſs, alternately, and conſequently, when it is day on one half of the earth, it is then night on the oppoſite half.

Now by this motion of the earth round its center or axis every 24 hours, there is a conſtant ſucceſſion of light in all parts as they are turned towards the ſun, and of darkneſs in theſe parts as they move out of theſe rays and are turned from the ſun. For, as the earth never ſtands ſtill, but is conſtantly turning round its axis every 24 hours; that half of the earth which is now in darkneſs, will, in 12 hours time (when the earth has made half a revolution round its axis) be turned towards the ſun, and conſequently, will be all in the light, and the other half, which before was in the light, will then be turned from the ſun, and conſequently, will be all in darkneſs. And ſo, by this continual motion of the earth round its axis, there is an alternate ſucceſſion of day and night, over all the parts of the terraqueous globe.

For, while the earth is turning round its center or axis, towards the eaſt, all people who live on thoſe parts of the earth which are juſt entering into the rays of light, will ſee the ſun appearing to riſe in the eaſt, and as the earth continues to move farther round, towards the eaſt, the ſun will ſeem to riſe higher and higher, and will appear to move round the earth towards the weſt, till the ſaid parts be turned directly towards the ſun, and then the ſun will be due ſouth to thoſe parts, and will appear no higher that day, and then it will be noon or mid-day at thoſe places: And as the earth ſtill continues moving farther round eaſtward, thoſe parts of it which are now oppoſite the ſun, and which before were turned continually more and more towards the ſun, will now be turned continually more and more from the ſun, and the ſun, by reaſon of the curviture of the earth intervening, will ſeem to deſcend gradually lower and lower, and will at length appear to ſet in the weſt.

Hence we clearly ſee, that the motion of the earth round its center or axis from weſt to eaſt, is the true cauſe of day and night, and that the ſun, moon, and ſtars, &c. ſeeming to move round the earth every 24 hours from eaſt to weſt, is only a falſe appearance; as will be more fully explained farther on.

But there are many people, and eſpecially the unlearned, who cannot conceive how all things are kept in their places, and prevented from falling from off the earth, when, by the motion of the earth round its axis, they ſeem to be turned, as it were, topſeturvy every 24 hours.

Now in order to have a clear underſtanding how all things are kept in their places and prevented from falling from the earth, while the earth is turning round its axis, it is to be obſerved, that there is a property or quality in all matter, which is of an attractive nature, that is, has the power of attracting or drawing all things to it, in the ſame manner as a loadſtone or magnet attracts or draws pieces of iron or ſteel to itſelf, and this power of attraction, always acts with a force in proportion to the quantity of matter which any body or ſubſtance contains. For inſtance, the earth attracts or draws any kind of matter or ſubſtance that is 20 ſtone weight with double the force that it attracts any other body of matter, which is only 10 ſtone weight, therefore the heavier any body of matter is, it is held to the earth, by the power of attraction, with ſo much the greater force, and conſequently, there is no poſſibility of any thing falling from the earth, what ever ſide it be on, for all things are kept to the earth's ſurface on all ſides by this power of attraction, which laying hold of all bodies according to their denſities or quantities of matter, (without regard to their bulks) conſtitutes what we call their weight or gravity.

Now as this attracting power of the earth conſtitutes the weight of all bodies upon or near the earth's ſurface, the words attraction and gravity, may, in reſpect to the earth, be uſed as ſynonimous terms, for they both ſignify the ſame thing, namely, the power or law by which all bodies tend or are drawn to the earth; and this power of attraction always acts with the ſame force on all ſides of the earth.

It is very ſurprizing to ſee what a vaſt variety of effects are produced from this ſingle principle, gravitation or attraction; it is a property which is found to be univerſally diffuſed throughout all matter, and is the very cement of all bodies. It is owing to this attractive or gravitating principle that the earth itſelf (as well as all other ſolid bodies of matter) is kept together in one ſolid maſs: For, if this force of attraction were to ceaſe, all the particles of matter of which the earth is compoſed, would fly off, by reaſon of the motion of the earth round its axis, in the ſame manner as water flies off from a trundled mop, or as dirt flies off from the wheel of a coach when the wheel is turning round: But by this wonderful power of attraction or gravity, all the parts adhere cloſe together, and form a ſolid body of matter.

Now as the earth attracts and holds all bodies to its ſurface with a power or force in proportion to their reſpective quantities of matter, we clearly ſee the true cauſe; why houſes and the moſt lofty towers, &c. ſtand firm and ſecure on all ſides of the earth, without the leaſt danger of their falling from the earth: For, the earth being round like a globe or ball, it has not an upper and an under ſide, as ſome weakly imagine, but all ſides of it are actually uppermoſt.

For inſtance, people that travel from England to all parts of the earth, find themſelves on the upper ſide of the earth, go where they will, and have the ſun, ſky, and ſtars, appearing and diſappearing alternately above them, in the ſame manner as when they were in England. And thoſe people who live oppoſite to us, on the other ſide of the earth, and have their feet oppoſite to our feet, and their heads ſeeming to hang down, as it were, with reſpect to our poſition, ſtand and walk as firm and upright as we do, and have the ſun, ſky, and ſtars, appearing, in ſucceſſive order, above them in the ſame manner as we have; although, if we could ſee through the earth to the oppoſite ſide, our ſide of the earth would appear to be uppermoſt, and theirs undermoſt, and the people would ſeem to be hanging on the earth by their feet, and we would appear to them in the ſame poſition; but let us travel round the earth to where they are, and we will find that they are on the upper ſide of the earth as well as we were, and that all things are held to the earth's ſurface there, by the power of attraction, in the ſame manner as they are on our ſide of the earth.

Now whatſoever difficulty ſome people may have in comprehending theſe things, ſuch may reſt aſſured that this account is not a mere chimerial idea; but a real and irrefragable truth, founded upon the moſt indubitable principles of reaſon, ſcience, and obſervation, and confirmed by all men who have travelled round the earth. For, when our great circumnavigators, Anſon, Cook, Banks, Solander, and many others, were on that part of the South Sea which is on the other ſide of the earth, exactly oppoſite to England, notwithſtanding their feet were then oppoſite to our feet in England, yet they ſtill found themſelves on the upper ſide of the earth, and had no more difficulty in ſtanding, walking, and ſailing there, than when they were on our ſide of the earth; although if we, in England, could have ſeen them, when they were oppoſite to us, on the other ſide of the earth, the ſea would have appeared running on the under ſide of the earth, and the ſhips ſailing upon it with their bottoms

toms upwards, and their maſts downwards; and all other things would ſeem to be turned upſide down, as it were, with reſpect to the poſition of things with us; and in like manner all things with us, would appear in the ſame poſition to them.

From theſe falſe appearances, we clearly ſee that our eyes and imaginations would often lead us into very great errors and abſurdities, did not ſound reaſon, learning, and experience, teach us to form right notions of the nature, conſtitution, and true cauſe of things.

There is another falſe appearance, ſimilar to the above, which falls daily under our obſervation, and is cauſed by the earth turning round its center or axis every 24 hours from weſt to eaſt.

This motion of the earth from weſt to eaſt, makes the ſun, moon, and ſtars, &c. appear to move round the earth the contrary way, namely, from eaſt to weſt, as we have already obſerved; and did we not know that this appearance is cauſed by the earth turning round its center or axis, we would believe that the ſun, and all the reſt of the heavenly bodies, do actually move round the earth every 24 hours as they ſeem to do.

This falſe appearance of the heavenly bodies, ſeeming to move round the earth, may be more familiarly illuſtrated by the following experiment.

Let us place ourſelves in a boat, in the middle of a lake, or large pond, and let the boat be cauſed to turn round as on a center, from weſt to eaſt, that is, towards the left hand; then, while the boat is moving round from weſt to eaſt, all objects on the ſide of the lake or pond will appear to move round the boat the contrary way, namely, from eaſt to weſt; and did we not know that the boat moved round, we would imagine that all things on the ſide of the lake did really move round the boat.

An Explanation of the true Cauſe of Eclipſes of the SUN and MOON.

An eclipſe of the ſun always happens at the time of new moon, when the moon gets in betwixt us and the ſun, and prevents the ſun from ſhining upon that part of the earth where we live; for, when the moon is directly betwixt us and the ſun, the moon's ſhadow falls upon the earth, and hides part of the ſun from our ſight; and by that means cauſes (what we call) an eclipſe of the ſun, to all that part of the earth where her ſhadow touches or covers.

Thus, when the earth is in that part of its orbit marked W, (ſee the repreſentation of the ſolar ſyſtem) the moon is at her change at D, and being then directly betwixt the ſun and the earth, her ſhadow falls upon the earth at *a*, and cauſes an eclipſe of the ſun to all that part of the earth where her ſhadow touches, namely, from *a* to Q.

Of an Eclipſe of the MOON.

An eclipſe of the moon always happens at the time of full moon, when the earth gets in betwixt the ſun and the moon, and prevents the ſun from ſhining on that ſide of the moon which is next or oppoſite to the earth; for when the earth is directly betwixt the ſun and the moon, the earth's ſhadow falls upon the moon, and makes her appear of a dark or blackiſh colour, on all that part of her where the ſhadow touches, and by that means cauſes what we call an eclipſe of the moon.

Thus, when the earth is in that part of its orbit marked G, the moon is at her full at *e*, and the earth being then directly betwixt the ſun and the moon, the earth's ſhadow falls upon that ſide of the moon which is next the earth, and cauſes her to be eclipſed at that time.

It is to be obſerved, that if the moon's orbit had no inclination to the earth's orbit, that is, if the moon's orbit coincided or lay in the ſame plane with the earth's orbit, there would be an eclipſe of the ſun at every change, and alſo an eclipſe of the moon at every full; for, in this caſe, the centers of the ſun, moon, and earth, would all be oppoſite each other, or nearly ſo, at every full and change; and by that means the moon's ſhadow would fall upon the earth at every change, and the earth's ſhadow would fall upon the moon at every full, and we ſhould have as many eclipſes every year as there are new and full moons; but this is far from being the caſe, for the greateſt number of eclipſes that can poſſibly happen in one year, cannot exceed ſeven, and often not above two or three happen in a year.

Now the reaſon why there is not an eclipſe at the time of every new and full moon is this; becauſe the moon's orbit is inclined to the earth's orbit in an angle of about 5 degrees, and, on that account, one half of the moon's orbit is above the earth's orbit, and the other half below it; and theſe orbits interſect or cut each other in two oppoſite points, called the nodes.

Now as an eclipſe can never happen, but when the centers of the ſun, moon, and earth are directly oppoſite each other, or nearly ſo, it is plain that they can never be in that ſituation but when the moon changes, or is at full, when ſhe is either in or near one of thoſe two points of her orbit, called the nodes.

For when ſhe changes, or is at full, in any other part of her orbit, ſhe is either above or below the earth, and therefore her ſhadow can neither fall upon the earth, nor the earth's ſhadow upon her, at theſe times.

Thus, for inſtance, when the earth is in that part of its orbit marked ſpring, the moon changes at *y*, and being then not quite directly betwixt the ſun and the earth, but in that part of her orbit which is below the earth's orbit, her ſhadow falls, by that means, below the earth at S, and therefore there can be no eclipſe of the ſun at the time of that new moon. And, when the moon has got round to the oppoſite part of her orbit, marked *r*, ſhe is at her full, and being then in that part of her orbit which is above the earth's orbit, the earth's ſhadow, by that means, falls below the moon at *r*, and conſequently there can be no eclipſe of the moon, at that full moon.

And here it may be obſerved, that as one half of the moon's orbit is above the earth's orbit, and the other half below it, it moſtly happens, that, when the moon changes when ſhe is in that part of her orbit, which is below the earth's orbit, ſhe will be above the earth's orbit when ſhe comes round to the oppoſite part of her orbit, namely, at her next full. And, on the contrary, when the moon changes when ſhe is in that part of her orbit which is above the earth's orbit, ſhe will be below the earth's orbit when ſhe comes round to the oppoſite point of her orbit, that is, at her next full, and in all theſe caſes there can be no eclipſe; for, except the centers of the ſun, moon, and earth, be directly oppoſite to each other, or nearly ſo, at the time of full and change of the moon, there can be no eclipſe.

Thus, for inſtance, in this latter caſe, when the earth is in that part of its orbit marked autumn, the moon changes at Z, and being then in that part of her orbit which is above the earth's orbit, her ſhadow, by that means, falls above the earth at E, and therefore there can be no eclipſe of the ſun at that new moon.

And, when the moon has got round to the oppoſite part of her orbit, marked *d*, ſhe is at her full, and being then in that part of her orbit which is below the earth's orbit, the earth's ſhadow, by that means, falls above the moon at *d*, and conſequently there can be no eclipſe of the moon at the time of that full moon.

It may farther be obſerved, that there is a particular kind of an eclipſe of the ſun, called an annular eclipſe, ſo named, becauſe the ſun appears like a bright ring all round the dark part which is eclipſed.

Such an eclipſe as this is repreſented in that part of the earth's orbit or ecliptic, marked ſummer, where the moon is at her change at *n*, and very near one of her nodes; but being then at her greateſt diſtance from the earth, her ſhadow does not reach ſo far as the earth, but hangs even over it, and on that account the moon cannot hide all the face of the ſun from our ſight, and the edge of the ſun appears like a luminous ring all round the dark part of the ſun which is eclipſed. But eclipſes of this kind very ſeldom happen; for altho' the moon changes, from time to time, in all parts of her orbit, yet it rarely happens that ſhe is both in her nodes, and alſo at her greateſt diſtance from the earth at the time of her change, and this is the reaſon why annular eclipſes happen ſo ſeldom.

From the above explanation of eclipſes, it appears very evident, that the darkneſs at our Saviour's cruciſixion was not cauſed by an eclipſe of the ſun, as ſome have ignorantly imagined; for he ſuffered on the day on which the Jewiſh paſſover was eaten, and it is well known that the Jews always kept the paſſover, not at the time of the new moon, but at the full moon, at which time no eclipſe of the ſun could happen, and therefore that great and memorable darkneſs did not proceed from any natural cauſe whatſoever, but was undoubtedly a miracle.

Of the STARS.

Thoſe bright objects in the heavens, which we call ſtars, are not dark bodies like our earth and the reſt of the planets in our ſolar ſyſtem; for it is proved, by a multitude of experiments and obſervations, that they all ſhine by their own light, and not by any light they receive from our ſun. For the ſtars are at ſuch an immenſe diſtance from our ſun, that they cannot poſſibly receive any light from him, ſo as to reflect it back to the earth, and make them even viſible to us; much leſs to appear of ſuch a bright and ſhining luſtre, as we ſee them have.

It is well known, that the earth is nearly eighty-two millions of miles from the ſun, and by many diſcoveries, it is now proved beyond all doubt, that the ſtars are at leaſt 400.000 times farther from us than we are from the ſun, that is, four hundred thouſand times, conſequently, the neareſt ſtar we behold, is at leaſt 32800000000000 of miles from the earth, that is, thirty-two billions, eight hundred thouſand millions of miles.

This amazing diſtance of the ſtars clearly proves, that they are all as big, or bigger than our ſun, otherwiſe we could not ſee them ſo far off; for, if our ſun was placed as far from us as the ſtars are, he would appear no bigger than they do, and if the moon and planets belonging to our ſyſtem, were placed at that diſtance, they would be quite inviſible.

As it is proved beyond all manner of doubt, that the ſtars are immenſe globes of fire, all as big or bigger than our ſun, it appears very evident that they are placed in the univerſe for the ſame ends and purpoſes as our ſun is, and that they all have planets revolving continually round them in the ſame manner as our ſun has

Inſtead then of one ſun and of one world only in the univerſe, as the unlearned imagine, the ſcience of aſtronomy diſcovers to us an infinite number of ſuns, ſyſtems, and worlds, diſperſed through boundleſs ſpace at immenſe diſtances one from another; and it is the opinion of the greateſt aſtronomers and philoſophers, that thoſe different worlds, or diſtant ſyſtems, have a relative motion among one another; at the ſame time they are relatively moving in orbits round a central world at an immenſe diſtance from that center, counterpoiſing each other by the general law of gravitation; and, that all the ſeveral planets belonging to every ſyſtem, are covered with ſeas, rivers, graſs, and trees, &c. as our earth is, and are all inhabited by people and other living creatures ſuited to thoſe regions, in the ſame manner as our earth is inhabited; having all the viciſſitudes of ſeaſons, ſummer and winter, ſpring and autumn, day and night, lengthening and ſhortening of days, &c. in the ſame manner as we have.

When we conſider theſe amazing ſcenes of creation, and ſtretch our thoughts to the innumerable orders of beings that inhabit all thoſe grand and ſpacious ſyſtems, how muſt we be loſt in wonder at the conſideration of the *Creator* himſelf, whoſe operations are ſo great and marvellous, that he can ſummon into being, with equal eaſe, a ſingle grain, or ten thouſand worlds.

An explanation of old and new Style, ſhewing the reaſon and neceſſity for altering the old Style.

The interval of time betwixt any ſeaſon, and the return of the ſame ſeaſon again, has always been univerſally called a year; ſo that the length of a year, taking one year with another, has been nearly the ſame in all ages: But as the ancients were unacquainted with the motions of the heavenly bodies, and the true times in which the planets perform their courſes round the ſun, they were alſo ignorant of the exact length of the year, and on that account, they were obliged to have recourſe to ſuch methods as they ſuppoſed would anſwer neareſt to the return of the ſeaſons; and what appeared moſt natural to them, for this purpoſe was, the returns of new moon; for, as they obſerved 12 new moons to happen within the time of the general return of the ſeaſons, they therefore firſt divided the year into 12 equal parts, which they called months; and as they reckoned about 30 returns of morning and evening between the times of new moon and new moon, they therefore reckoned their month to conſiſt of 30 days, and their year, or 12 months, to contain 360 days; and this is what is generally underſtood by the lunar year of the ancients.

But in length of time it was found, that this year did not agree with the riſing and ſetting of the ſun on the return of the ſame month, and day of the month, and that the ſeaſons gradually fell later in the year than they had been formerly obſerved; this put them upon correcting the method of eſtimating their year, which they did from time to time by taking a day or two from the month as often as they found it too long for the courſe of the moon; and by adding a month, called an intercalary month, as often as they found 12 lunar months to be too ſhort for the returns of the four ſeaſons and fruits of the earth: This kind of year, ſo corrected from time to time, is what is to be underſtood by the luniſolar year; which was anciently uſed in moſt nations, and is ſtill among the Arabs and Turks.

This confuſed way of correcting the year continued till the time of Julius Cæſar, (about 40 years before the birth of our Saviour) when it was diſcovered that the earth moved round the ſun in about 365 days, 6 hours, which time was found to agree with the return of the ſeaſons without any ſenſible error for many years; and as theſe 6 hours of odd time in every year, amounted to a day in four years, the Emperor ordered that every fourth year ſhould contain a day more than 365 days, namely, 366 days.

The year thus corrected by Julius Cæſar, is what we call the Julian account or old ſtyle, and was uſed by moſt chriſtian ſtates till the year of our Lord 1582, when it was diſcovered that the true time in which the earth moves round the ſun is 365 days, 5 hours, and 49 minutes, which is 11 minutes leſs than the Julian year, conſequently, the Julian account, or old ſtyle, made the year longer than it really is, by 11 minutes; but as this ſmall error of 11 minutes only amounts to a day in about 130 years, it was never taken notice of till about the year of our Lord 1580. For, in the year 325, at the Council of Nice, when the Biſhops met to ſettle, among other things, the day for the celebration of Eaſter, the vernal equinox, that is, the day in the ſpring when the ſun roſe at ſix and ſet at ſix, happened on the 21ſt of March; but about the year of our Lord 1580, that is, about 1255 years afterwards, the ſpring equinox fell on the 11th of March; which clearly proved that the ſeaſons were then 10 days later than at the time of the Nicene Council; and if this ſmall error in the length of the year had been ſuffered to go on uncorrected, the ſeaſons would have been kept conſtantly retreating backward at the rate of one day in about every 130 years; ſo that, in proceſs of time, Chriſtmas would fall when we now have mid-ſummer.

In the year of our Lord 1581, Gregory the XIIIth, who was Pope at that time, obſerving that this difference of time in the falling of the equinox would affect the intention of the Nicene Council, concerning the time of the year appointed by them for the celebration of Eaſter; He therefore ordered that, in the year 1582, the 5th of October ſhould be called the 15th, and ſo on, whereby the 10 days taken off or dropped would cauſe the time of the ſpring equinox to fall on the 21ſt of March, as at the time of the Nicene Council.

And, that the ſeaſons might be prevented from going backwards and falling a day later every 130 years, as they did by the Julian account, or old ſtyle, he farther ordered that, from the time of this alteration of the ſtyle, the years ſhould be reckoned as they uſed to be by the Julian or old ſtyle, but that, as often as the 11 odd minutes, in the over-length of the true year, ſhould amount to a whole day, a day ſhould be dropped, or left out, by which means the ſeaſons would, in future, be prevented from going backwards, and the ſpring equinox would always fall on the 21ſt of March, as it actually has done ever ſince.

An inſtance of dropping or leaving out a day will be ſeen in the year 1800; for as every fourth year is a leap-year (according to our common reckoning) the year 1800, ſhould be leap-year, but as the 11 odd minutes of over time in every year will, from the time of the laſt correction of the year in 1700, amount to a day, a day will be dropped or left out, and on that account the year 1800, will only be a common year, and February, inſtead of having 29 days, will only have 28 days, and by reaſon of leaving out a day in that year, there will not be a leap-year from 1796, till 1804, and then the leap-years will proceed again in their regular order, till the 11 odd minutes (which are reckoned too much every year) amount to a whole day, and then another day will be dropt or left out; and ſo on, by leaving out a day at the end of every 130 years, or as often as the 11 odd minutes amount to a whole day, the year by this means is corrected, and the ſeaſons are prevented from going backwards; ſo that they will, by this correction, always happen at the ſame time of the year.

This alteration or correction of the Julian account or old ſtyle, by Pope Gregory, is called the gregorian or new ſtyle, and was received and uſed in moſt chriſtian ſtates; but ſome, at that time, choſe to continue the Julian or old ſtyle; among whom were the Engliſh; but they in the year of our Lord 1752, obſerved, that from the time of the Nicene Council, in the year of our Lord 325, to the year 1752, (being an interval of 1427 years) the ſeaſons had fallen back 11 days; for, at the Nicene Council, the ſun roſe at ſix and ſet at ſix, on the 21ſt of March; but in the year 1752, the ſun roſe at ſix and ſet at ſix, on the 10th of March, which clearly proved, that the ſeaſons fell later then, by 11 days, than they did in the year 325. Therefore, in conſequence of this obſervation, an act of parliament was made, that, in the year 1752, the old ſtyle (on account of its being found not correct) ſhould ceaſe, and that the gregorian or new ſtyle ſhould henceforth be uſed throughout the Britiſh dominions, and in order to reſtore the ſeaſons to their former times, and cauſe the ſpring equinox to fall always on the 21ſt of March, as it did at the Nicene Council, the 11 days, which the ſeaſons had fallen back were drop't or left out in the month of September 1752, by calling the 3d of that month the 14th, and ſo on.

Of the Motion of the Planets, ſhewing by what Law or Cauſe they move round the Sun.

Daily obſervations ſhew that all bodies when put in motion, move in ſtraight lines, except ſome other power or cauſe draw them out of that direction. And if a body be put in motion in open ſpace, where it meets with no reſiſtance, neither to draw it out of its rectilinear courſe nor retard its motion, that body would move for ever in a ſtraight line with the ſame velocity or ſwiftneſs that it acquired at its firſt beginning to move; for, as a body at reſt cannot put itſelf in motion, neither can a body in motion ſtop itſelf nor move ſlower.

Therefore, when we ſee a body in motion, we conclude that ſome other power or cauſe muſt have given it that motion. And when we ſee a body in motion move ſlower and ſlower till at laſt that motion ceaſes, we conclude that ſome other body or cauſe ſtopt it.

If a body be acted upon by two forces at once, in different directions, it will follow the direction of neither, but will move in a courſe compounded of both theſe motions or forces. Therefore, when we ſee a body moving in a circular form, we conclude that it muſt be acted upon by two powers or forces at leaſt; namely, one impelling it forward in a ſtraight line, and another drawing it off from that rectilinear courſe.

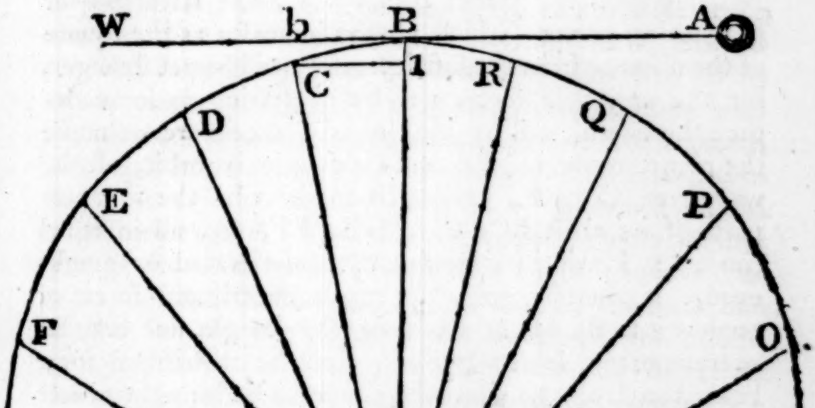
Now as the planets are placed in open ſpace, void of all ſenſible reſiſtance, they would, when once put in motion, move for ever in ſtraight lines, if there was no other force or power to draw them off from that direction; but the ſun (being heavier, and containing more matter than all the planets put together) does, by his attractive power pull or draw, as it were, the planets off from that rectilinear courſe which they would otherwiſe have continued to move in, and by that means compels them to move continually round him, in a circular form.

For, by the projectile force of the planets (which the Almighty impreſſed upon them at their creation) they are always endeavouring to fly forward in ſtraight lines; but by the attraction of the ſun they are pulled out of that direction into a circular motion; for, while the planets are endeavouring to move forward in ſtraight lines, the ſun (by his attraction) endeavours, as it were, to draw them to himſelf, and theſe two forces, namely, the projectile force of the planets, and the attractive force of the ſun, being ſo admirably adjuſted, by infinite wiſdom, that neither of them can overcome the other; the planets and comets, by this means, are kept in perpetual motion round the ſun.

Theſe two properties of the ſun and planets, namely, the projective force by which the planets endeavour to move forward in ſtraight lines, and the attractive force of the ſun, which endeavours to draw the planets towards himſelf, conſtitute that admirably grand law by which the planets and comets are kept in their orbits, and compelled to move continually round the ſun.

Which may be clearly demonſtrated thus, ſee the following figure or ſcheme, where S repreſents the place of the ſun, and the curve line BCDEFGHIKLMNOPQRB, the orbit or path in which the earth or any other planet moves round the ſun.

Now if the planet A be projected along the right line A B W, in open ſpace, where it meets with no reſiſtance, and is not drawn aſide by any other power or



force, it will for ever go on with the ſame velocity or ſwiftneſs it acquired at firſt, and in the ſame direction: For the force that moves it from A to B, in any given time will carry it from B to W, in as much more time; and ſo on, their being nothing to obſtruct or alter its motion.

But if, whilſt the projectile force would carry the planet along the ſtraight line from B to b, the ſun's attraction (which conſtitutes the planet's gravitation) ſhould bring it down from B to 1, the attracting or gravitating power of the ſun would then be too ſtrong for the projectile force; and would cauſe the planet to move in the curve BC. When the planet comes to C, the attracting or gravitating power (which always increaſes as the ſquare of the diſtance from the ſun decreaſes) will be yet ſtronger, for the projectile force, and by conſpiring in ſome degree therewith, will by that means, accelerate or make the planet move quicker and quicker in its orbit, all the way from C to K, cauſing it to deſcribe the areas or parts of its orbit BC, CD, DE, EF, &c. all in equal times *: Having its motion thus accelerated or quickened, it thereby gains ſo much centrifugal force or tendency to fly off at K, along the ſtraight line Kk, as overcomes the ſun's attraction, and the centrifugal force being too ſtrong to allow the planet to be brought nearer the ſun, it goes off and aſcends in the curve K L M N, &c. its motion decreaſing as gradually from K to B, as it increaſed in the other half of its orbit, namely, from B to K; becauſe the ſun's attraction now acts againſt the planet's projectile motion, juſt as much as it acted with it before, and by that means cauſes the planet to move ſlower and ſlower all the way from K to B.

When the planet has got round its orbit to B, its projectile force is as much diminiſhed or decreaſed, from its mean ſtate, about G or N, as it was augmented or increaſed at K; and ſo, the ſun's attraction being more than

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* For the planets in their motion round the ſun deſcribe equal areas in equal times, that is, the planet moves from B to C, from C to D, from D to E, from E to F, &c. &c in the ſame intervals of time; and the ſeveral ſpaces, BCS; CDS, DES; EFS, &c. &c. are all of equal area: This is what is meant by the planet's deſcribing equal areas in equal times.

than ſufficient to keep the planet from going off at B, along the ſtraight line BbW, it is compelled to move round the ſun again in the manner as before, by virtue of the ſame forces or cauſes, and ſo on continually.

Hence we ſee the reaſon why the planets move continually quicker and quicker in their orbits, during one half of their periods round the ſun, and continually ſlower and ſlower during the other half of their periods; for when the planet is at B, it is at its greateſt diſtance from the ſun, and conſequently is then leaſt attracted by the ſun; but as the planet continues to move forward in its orbit from B round to K, deſcribing that half of its orbit, marked, BCDEFGHIK, it approaches continually nearer and nearer the ſun, and is, on that account, more and more attracted by the ſun, and by that means has its motion continually increaſed or quickened all the way from B to K: But when the planet comes to that part of its orbit marked K, it then begins to move contrary to the attraction of the ſun, that is, the attraction of the ſun acts then againſt the motion of the planet, and cauſes it to move continually ſlower and ſlower all the way from K to B; and when the planet comes again to B, it begins to move quicker and quicker as before, by reaſon of its approaching continually nearer and nearer the ſun.

Hence alſo we may ſee the reaſon why thoſe planets which are near the ſun move quicker in their orbits than thoſe which are farther from the ſun: For as the attraction of the ſun increaſes the motions of the planets more and more, the nearer and nearer they approach towards him, thoſe planets which are neareſt the ſun, being moſt attracted by the ſun, will conſequently move quicker in their orbits than thoſe which are farther from the ſun, and are leſs attracted.

A TABLE,

Shewing the ſpecific gravity of bodies, that is, ſhewing how much one kind of matter is heavier or lighter than any other kind, being of the ſame ſize or bulk.

THE following Table, ſhews the ſpecific gravity of about 60 different kinds of matter, with the weight of both a ſolid foot, and ſolid inch, avoirdupoiſe weight; and alſo the weight of a ſolid inch, troy weight.

Note. Avoirdupoiſe weight contains 16 ounces in the pound, and troy weight 12 ounces.

Names of Bodies or different kinds of Matter.	Specific Gravity.	Weight of a ſolid foot, Avoirdupoiſe.	Weight of a ſolid inch, Avoirdupoiſe.	Weight of a ſolid inch, Troy.
		Pounds.	Pounds.	Ounces.
Fine Gold	19.640	1227.5	.71635	10.3592
Standard Gold	19.520	1220.	.70601	9.9626
Quickſilver	13.761	859.95	.49765	7.3844
Lead	11.313	707.05	.40917	5.9840
Fine Silver	11.091	693.18	.40115	5.8500
Standard Silver	10.629	664.3	.38444	5.5568
Copper	8.769	548.06	.31716	4.7471
Plate Braſs	8.350	508.47	.29426	4.4042
Caſt Braſs	8.104	506.27	.29298	4.2724
Steel	7.850	490.62	.28392	4.1421
Bar Iron	7.764	485.24	.28081	4.0313
Block Tin	7.238	417.91	.24179	3.8615
Caſt Iron	7.135	445.83	.25806	3.8065
Lead Ore	6.200	387.5	.22424	3.2702
Loadſtone	5.106	319.11	.18467	2.7240
Blue Slate	3.500	218.57	.12649	1.8672
Veined Marble	2.702	168.8	.09772	1.4294
Common Glaſs	2.600	162.5	.094033	1.3608
Flint Stone	2.582	161.37	.09338	1.3514
Portland Stone	2.570	160.62	.09295	1.3451

Names of Bodies or different kinds of Matter.	Specific Gravity.	Weight of a solid foot, Avoirdupoiſe.	Weight of a ſolid inch, Avoirdupoiſe.	Weight of a ſolid inch, Troy.
		Pounds	Pounds.	Ounces.
Freeſtone	2.352	158 24	.09157	1.2310
Brick	2.000	125.	.07233	1 0468
Alabaſter	1 888	118.02	.06831	.9884
Ivory	1.832	114.5	.06626	.9585
Horn	1.832	114 5	.06626	.9585
Brimſtone	1.800	112.5	.06510	.9494
Clay	1 712	107.	.06192	.9025
Lignumvitæ, or Wood of Life	1.327	82.92	.04798	7
Boiled Water	1.280	78.25	.04528	.6751
Coal	1.255	95.72	.05539	.6619
Pitch	1.150	71.87	.04159	.6067
Mahogany	1.063	66.44	.03844	.5607
Box-wood	1.030	64.37	.03726	.5433
Milk	1 033	64.36	.03725	.5437
Sea Water	1 033	64.36	.03725	.5437
Rain Water	1.000	62.5	.03617	.5274
Red Wine	.993	62.06	.03591	.5231
Bees Wax	.995	62 18	.03598	.5248
Lintſeed Oil	.930	58.25	.03371	.4916
Proof Spirits of Brandy	.927	57.98	.03355	.4893
Oak	.915	57.19	.03309	.4890
Olive Oil	.913	57.18	.03302	.4815
Beech	.854	53.37	.03088	.4504
Elm	.800	50.	.02893	.4219
Aſh	.800	50.	.02893	.4219
Wainſcot	.747	46.7	.02702	.3940
Cedar	.613	38.31	.02217	.3233
Yellow Fir	.657	41.06	.02376	.3465
White Fir Deal	.569	35.56	.02058	.3000
Cork	.246	32.3	.01869	.1266
Air	.0012	.075	0000434	000633

Uſe of the TABLE of Specific Gravity.

To find the weight of any ſolid body or quantity of matter.

Rule. Find the ſolid content of the body either in inches or feet, then multiply the ſolid inches or feet contained in the body, by the weight of a ſolid inch or foot of the ſame kind of matter, as ſhewn in the table, and the product will be the weight required.

Example 1ſt. What is the weight of a piece of dry oak, that contains 14 ſolid feet?

By the table, a ſolid foot of oak weighs 57.19 pounds, avoirdupoiſe weight, which being multiplied by 14, the product is 800.66 pounds, that is, 800 pounds, and .66 of a pound; which being reduced into ſtones, of 14 pounds to the ſtone, makes 57 ſtone, 2 pounds, and 10 ounces. Anſwer.

Ex. 2d. What is the weight of a piece of dry yellow fir, that contains 36 and an half ſolid feet?

By the table, the weight of a ſolid foot of fir is 41.06 pounds, avoirdupoiſe; which being multiplied by 36.5 feet, the product is 1498.696 pounds; which being divided by 14, the pounds in a ſtone, gives 107 ſtone 11 pounds. Anſwer.

Ex. 3d. If an air balloon contain 3360 ſolid or cubic feet, and weigh, when filled with gas or contaminated air, 6 ſtone, or 84 pounds; what weight, excluſive of its own weight, will it be able to carry up into the atmoſphere?

By the table, a ſolid foot of air weighs .075 of a pound, avoirdupoiſe; which being multiplied by 3360 ſolid feet, the product is 252.000 pounds, that is, 252 pounds, the weight of pure air which the balloon would contain; from which take 84 pounds, the weight of the balloon, leaves 168 pounds, or 12 ſtone, the weight which the balloon will bear up in the atmoſphere. Anſwer.

To find the ſolid content of any body or quantity of matter.

Rule. Find the weight of any body in pounds, then divide the weight of the body, by the weight of a ſolid inch or foot of the ſame kind of matter as ſhewn in the table, and the quotient will be the ſolid content of the body in inches or feet accordingly.

Example 1ſt. What is the ſolid content of a piece of marble, that weighs 19488 pounds, avoirdupoiſe?

By the table, the weight of a ſolid foot of marble is 168.8 pounds, and 19488 pounds being divided by 168.8 pounds, the quotient is 115.5 ſolid feet, that is, 115 and 1 half ſolid feet. Anſwer.

Ex. 2d. What is the ſolid content of a piece of mahogany that weighs 9744 pounds?

By the table, the weight of a ſolid foot of mahogany is 66.44 pounds; and 9744 pounds being divided by 66.44 feet, the quotient is 146.8 ſolid feet, that is, 147 feet nearly. Anſwer.

To find what proportion the ſpecific gravity of one kind of matter bears to that of any other kind, that is, to find how much one kind of matter is ſpecifically heavier, or lighter, than any other kind.

Rule. Divide the ſpecific gravity of one kind of matter, by that of any other kind, and the quotient being compared with unity or 1, will ſhew how much the one kind of matter is heavier or lighter than the other.

Example 1ſt. How much is a ſolid inch of fine gold ſpecifically heavier than a ſolid inch of rain water?

Note. The ſpecific gravity of water, being counted unity or 1 in the table, and all other bodies being compared with it, the table ſhews at ſight how much any kind of matter is heavier or lighter than rain water.

Thus, the table ſhews that fine gold is more than 19 times heavier than rain water; fine ſilver rather more than 11 times heavier; brick juſt twice as heavy; boiled water near three-tenths heavier; milk and ſea-water $\frac{33}{100}$ heavier; that is, thirty-three hundredths, or one-ninth, heavier; but red wine, bees wax, lintſeed oil, proof ſpirits of brandy, &c. &c. are lighter than rain water.

Note. All bodies which are ſpecifically lighter than water, or any other fluid, will ſwim in thoſe fluids; but if heavier they will ſink to the bottom.

Thus, beech, elm, aſh, fir, oak, &c. being ſpecifically lighter than water, will ſwim in that fluid; but lignumvitæ, mahogany, box-wood, &c. being ſpecifically heavier, will ſink, when immerſed in water.

Ex. 2d. How much is a ſolid inch, or foot, &c. of mahogany, ſpecifically heavier than a ſolid inch, foot, &c. of oak.

By the table, the ſpecific gravity of mahogany is 1.063, and that of oak, .915, then 1.063 being divided by .915, the quotient is 1.16, nearly; which ſhews, that mahogany is about 16---100 or one ſeventh ſpecifically heavier than oak.

Ex. 3d. What proportion does the weight of ſtandard ſilver bear to that of gold.

By the table, the ſpecific gravity of ſtandard gold, is 19.520, and that of ſilver, 10.629; then 19.520, being divided by 10.629, the quotient is 1.82, &c. which ſhews, that ſtandard gold is nearly double or two times the weight of ſtandard ſilver, that is, the weight of gold is to that of ſilver, as 1.82 is to 1.

To find the ſpecific gravity of any body or kind of matter, compared with rain water.

Rule. Weigh the body in water, and alſo out of water; and note the difference of the weights; then ſay, by proportion.

As that difference is to the weight of the body out of water, ſo is the ſpecific gravity 1, to the ſpecific gravity of the given body, counting the ſpecific gravity of rain water unity or 1, and comparing all other kinds of matter with it.

Example 1. If a body weighs 16 pounds in water, and 20 pounds out of water, what is the ſpecific gravity of that body?

Here the difference of the weights is 4 pounds, then as 4lb. is to 20lb. ſo is 1 to 5, the ſpecific gravity; that is, divide the weight of the body out of water, by the difference of its weight in and out of water, and the quotient will be the ſpecific gravity of that body.

Thus, 20 divided by 4, gives 5 the ſpecific gravity as above, which ſhews, that the body is 5 times heavier than rain water.

Ex. 2d. A ſolid inch of fine gold weighs 9 ounces and .831795 parts of an ounce in water, and 10 ounces and .359253 parts of an ounce out of water (troy weight) what is the ſpecific gravity, compared with water?

Here the difference of the weights, in and out of water, is .527458 parts of an ounce, for 9.831795 being taken from 10.359253, leaves .527458. Then 10.359273 the weight out of water, being divided by the ſaid difference, 527458 gives 19.640 the ſpecific gravity as in the table; hence, fine gold is nearly twenty times heavier than rain water.

RULES

To know the Weather by the MOON.

1ſt. If the new moon does not appear till the fourth day after her change, it prognoſticates a troubled and damp air for the whole moon.

2d. If the moon, either at her firſt appearance, or within a few days after, have her lower or upper horn obſcured or duſky, or any way ſullied, it denotes foul weather before the full; but if ſhe be diſcoloured or darkiſh in the middle, then ſtorms may be expected about the full.

3d. When the moon, on her fourth day, appears pure, bright, and ſpotleſs, with clear ſharp horns, that do not ſtand quite erect, it promiſes fair weather for the greateſt part of the moon.

4th. When the moon on her fourth, or fifth day, has her horns ſharp and erect, it denotes wind and ſhowers; but if her horns are erect and blunt, then rain or ſnow is to be expected.

The above obſervations have been attended to for many years, and never known to fail.

Note. When the moon's horns ſtand erect, her back or convex part hangs down towards the earth.

RULES

To know the Weather by the Leech Worm, commonly called a Loch Leech.

1ſt. Put a leech worm into a clear white glaſs-bottle, about three-fourths full of ſpring water, and cover the mouth with a piece of coarſe lin rag, (not a cork) ſo that the air may be admitted through the cloth, and ſet the bottle thus prepared, in the bottom of a window: Then,

2d. If the weather proves fine, the leech will lie motionleſs at the bottom of the bottle, coiled up in a ſpiral or circular form; but if it be going to be wet, it creeps up to the top of the bottle, and remains there till the weather be ſettled.

3d. If windy weather is approaching, the leech gallops through the water with great ſwiftneſs, and ſeldom reſts till it begins to blow hard.

4th. If thunder and rain are going to happen, it goes up to the top of the water, and diſcovers great uneaſineſs, in violent throws and convulſive-like motions for two or three days before.

5th, In froſty weather it lies continually at the bottom of the bottle, and if ſnow is approaching it goes up to the very mouth of the bottle, and there remains till the ſnow ceaſes.

Note. In ſummer, change the water once or twice a week, and in winter once a fortnight, or 10 days.

The bottle ſhould be of ſuch a ſize, as to hold upwards of a gill of water.

By a careful obſervation of the above Rules any perſon may know what kind of weather will happen every day throughout the year.

A Geographical Table,

Containing the Names of all the chief Cities in the World, ſhewing what Countries they are in, how far they are from England, and what way they lie, and alſo their Latitudes and Longitudes.

Note. In the following Table E, ſtands for eaſt, W, for weſt, N, for north, and S, for ſouth. Alſo D, ſtands for degrees and M, for miles.

Names of chief Cities	Names of Countries	Diſtance and bearing from London	Latitude	Longitude
		Miles	D : M	D : M
Agra	E. Indies	4420 SE	26 : 43 N	76 : 30 E
Aleppo	Syria	2170 SE	35 : 42 N	37 : 24 E
Algiers	Barbary	1000 S	36 : 50 N	3 : 16 E
Amſterdam	Holland	228 E	52 : 23 N	5 : 4 E
Annapolis	Maryland N A	3900 SW	39 : 0 N	76 : 50 W
Bergin	Norway	650 NE	60 : 10 N	5 : 40 E
Berlin	Pruſſia	600 E	52 : 33 N	13 : 32 E
Bern	Switzerland	460 SE	47 : 0 N	7 : 20 E
Bombay	E. Indies	4300 SE	19 : 0 N	71 : 30 E
Bokaria	Tartary	3300 SE	40 : 10 N	67 : 0 E
Boſton	N. England	3400 W	42 : 20 N	70 : 40 W
Bruſſells	Flanders	200 SE	50 : 50 N	4 : 6 E
Buenos Ayres	La-plata S A	7000 SW	34 : 35 S	57 : 45 W
Grand Cairo	Egypt	2100 SE	30 : 0 N	32 : 0 E
Calcutta	Bengal E. Ind	4900 SE	22 : 0 N	87 : 0 E
Cape of Goodhope	Hottentots Country	6100 S	34 : 7 S	19 : 35 E

Names of chief Cities.	Names of Countries.	Diſtance and bearing from London	Latitude.	Longitude.
		Miles.	D : M	D : M
Cape Horn	S. point of S A	8500 S W	56 : 35 S	66:55 W
Charles Town	S. Carolina	4300 S W	32 : 41 N	79:12 W
Copenhagen	Denmark	600 N E	55 : 45 N	12:50 E
Coſtantinople	Turkey	1500 S E	41 : 0 N	28:56 E
Damaſcus	Syria	2340 S E	33 : 15 N	37:20 E
Delly	E. Indies	4300 S E	29 : 0 N	76:30 E
Dublin	Ireland	316 W NW	53 : 20 N	6:28 W
Edinburgh	Scotland	360 N	55 : 58 N	3: 0 W
Epheſus	Turkey	1700 S E	38 : 16 N	27:53 E
Fez	Morroco	1200 S	33 : 30 N	6: 0 W
Gibraltar	Spain	1200 S	36 : 0 N	6: 0 W
Hague	Holland	240 E	52 : 10 N	4: 0 E
Hamburgh	Germany	400 N E	53 : 41 N	9:40 E
Hallifax	Nova Scoti	2900 W	44 : 40 N	63:15 W
Hanover	Germany	430 E	52 : 32 N	9:35 E
Havannah	Iſland of Cuba W. I.	4800 S W	23 : 0 N	84: 0 W
Jeruſalem	Paleſtine in Turkey	2300 S E	32 : 0 N	36: 0 E
Iſpahan	Perſia	3000 S E	32 : 50 N	51:30 E
Kingſton	Jamaica Iſl.	4840 S W	17 : 40 N	77: 0 W
Koningſburg	Pruſſia	920 E	44 : 43 N	21:35 E
Liſbon	Portugal	960 S W	38 : 42 N	8:53 W
Lima	Peru S. A.	6500 S W	12 : 10 S	77:30 W
Madrid	Spain	800 S by W	40 : 30 N	4:15 W
Madraſs	E. Indies	5200 S E	13 : 11 N	80:32 E
Mecca	Arabia	3000 S W	21 : 45 N	41: 0 E
Mexico	Mexico N A	6000 S W	20 : 0 N	103: 0 W
Moco	Arabia felix	3700 S E	13 : 40 N	43:50 E
Morocco	Barbary	3600 S E	30 : 32 N	6:10 W
Moſcow	Ruſſia	1600 E	35 : 45	37:51 E
New York	N. York N A	3500 S W	40 : 40 N	74: 0 W
Paris	France	217 S E	48 : 50 N	2:25 E
Pegu	E. India	6000 S E	17 : 0 N	97: 0 E
Pekin	China	5700 S E	40 : 0 N	116:28 E
Penſacola	Weſt Florida N. A.	3600 S W	30 : 32 N	87:20 W
Peterſburg	Ruſſia	1320 N E	60 : 0 N	30:25 E
Philadelphia	Penſylvania N. A.	3600 S W	40 : 0 N	75:20 W

Names of chief Cities.	Names of Countries.	Diſtance and bearing from London	Latitude.	Longi-tude.
		Miles.	D : M	D : M
Placentia	Newfound-land Iſland	2300 W	47 : 26 N	55: 0W
Pondechery	E. Indies	5300 S E	12 : 27 N	80: 0 E
Portobello	Terre Ferma N. A.	5300 S W	9 : 34 N	82: 5W
Port Royal	Jamaica Iſl.	4840 S W	10 : 0 N	77: 0W
Prague	Bohemia	670 E	50 : 0 N	14:20 E
Preſburg	Hungary	800 E	48 : 20 N	17:30 E
Quebec	Canada N.A.	3200 W	46 : 55 N	69:48W
Riga	Ruſſia	1100 N E	56 : 55 N	24: 0 E
Rome	Italy	900 S E	41 : 54 N	12:45 E
St Auguſtin	E. Florida	3500 S W	29 : 45 N	81:12W
St Jago	Chili S. A.	7600 S W	34 : 0 S	77: 0W
St Salvador	Brazil S. A.	7000 S W	13 : 0 S	38: 0W
Santa Fe	New Mexico	5000 S W	36 : 0 N	104: 0W
Savannah	Georgia N.A	4100 S W	31 : 55 N	80:20W
Stockholm	Sweden	900 N E	59 : 30 N	18: 8 E
Surat	Eaſt India	4500 S E	21 : 10 N	72:25 E
Tobolſky	Siberia	2600 N E	58 : 0 N	69: 0 E
Troy	Turkey	1400 S E	39 : 30 N	26:30 E
Tyre	Judea	2100 S E	32 : 32 N	36: 0 E
Vienna	Germany	760 E	48 : 20 N	16:20 E
Warſaw	Poland	900 E	52 : 15 N	21: 5 E
Williamſburgh	Virginia	3900 S W	37 : 12 N	76:48W

Note. In the above table, the firſt column ſhews the names of chief towns; the ſecond, the countries they belong to; the third, their diſtance and bearing from London; the fourth, their latitudes; and the fifth, their longitudes.

Example. What country is Williamſburg in; how far is it from England, and what way does it lie; alſo what latitude and longitude?

Anſwer. The table ſhews that Williamſburg is the capital of Virginia, and lies 3900 miles ſouth weſt from England; and is in latitude 37 degrees 12 miles north, and longitude 76 degrees 48 miles weſt, from the meridian of London.

A Brief ACCOUNT,

Of all the Chief Iſlands in the World; ſhewing what Seas they are in, how far they are from England, and what way they lie, and alſo what Latitude and Longitude they are in.

ANdaman Iſlands; in the Bay of Bengal, in the Eaſt Indies; they produce little but fruits, roots, and herbs. They lie 5800 miles SE from London, extending from 10 to 15 degrees N latitude, and from 90 to 93 E longitude.

Azores, or the weſtern Iſlands; [9 in number] in the Atlantic Ocean, 900 miles weſt of Portugal; they are fertile in corn, wine, and fruits. They lie 1600 miles S W from London, extending from 37 to 40 degrees N latitude, and from 25 to 32 W longitude.

Bahama Iſlands; [500 in number] in the Atlantic Ocean S E of Florida in Am. all moſtly barren except 12. They lie 4200 miles SW from London, extending from 21 to 27 degrees N latitude, and from 73 to 81 W longitude.

Banda or Nutmeg Iſlands; in the Eaſt India ocean, famous for mace, and nutmegs. Mace is the inner part of the huſk that covers the nutmeg. They lie 7900 miles SE from London, extending from 2 to 5 degrees S latitude, and from 126 to 130 E longitude.

Barbadoes, 21 miles long, and 14 broad; in the Atlantic Ocean, famous for rum, ſugar, ginger, indigo, tamarinds, &c. It lies 4300 miles SW from London, in 13 degrees N latitude, and 60 W longitude.

Bermudas or Summer's Iſlands; in the Atlantic Ocean E of Carolina, Am. Their chief produce is corn, cattle, fruits, &c. They lie 3600 miles SW from London, extending from 31 to 32 degrees N latitude, and from 63 to 65 W longitude.

Borneo, 800 miles long, and 700 broad; in the E. Indian ocean, famous for pepper, cotton, camphire, canes, diamonds, &c. It is 7400 miles S E from London, in latitude, 0, and longitude 107 E.

Botany Iſland, or new Holland, in the great ſouth ſea. It lies 11000 miles S E from London, extending, from 10 to 44 degrees S latitude, and from 110 to 156 E longitude.

In the year 1770, Captain Cook, in his Majeſty's ſhip the Endeavour, ſailed 2000 miles along the eaſt coaſt of New Holland, and gave all that part which he diſcovered, the name of New South-Wales: From his account we learn, that the natives go naked, are black, and men eaters, but of ſuch only as are taken in war.

That place called Botany Bay, (where criminals are ſent to) lies on the eaſt ſide of this vaſt country, in latitude 35 degrees ſouth, and longitude 152 degrees eaſt.

Canary Iſlands; [7 in number] in the Atlantic Ocean, 150 miles S W of Morocco; famous for wine and ſack. They lie 1800 miles SW from London, extending from 27 to 29 degrees N latitude, and from 12 to 21 W longitude.

One of theſe Iſlands called Teneriffe, has a mountain in the ſhape of a ſugar loaf, 3 miles high.

Cape Breton, 120 miles long, and 280 broad; in the Atlantic Ocean, E of Nova Scotia. It lies 2800 miles W from London, in 48 degrees N latitude, and 62 W. longitude.

Cape Verd Iſlands; [20 in number] in the Atlantic Ocean, 300 miles W of Cape Verd in Africa. They produce ſugar, wine, ſalt, cotton, oranges, &c. They lie 2800 miles S W from London, extending from 14 to 18 degrees N latitude and from 23 to 26 W longitude.

Caribbee Iſlands; in the Atlantic Ocean E of the gulph of Mexico; famous for rum, ſugar, cotton, ginger, indigo, tamarinds, &c. They lie 4300 miles S W from London, extending from 10 to 22 degrees N latitude, and from 59 to 63 W longitude.

Celebes or Macaſſer, 500 miles long, and 200 broad; in the Indian ocean, famous for peper, and opium. It lies 7600 miles S E from London, in latitude 0, and longitude 124 degrees E.

Ceylon, 250 miles long and 200 broad; in the E. India ocean, famous for cinnamon, long pepper, &c. It lies 5600 miles S E from London, in 10 degrees N latitude, and 82 E longitude.

Cuba, 700 miles long, and 70 broad; in the Atlantic Ocean, E of the gulph of Mexico; famous for ginger, pepper, aloes, caſia, maſtic, &c. It lies 4800 miles S W from London, in 19 degrees N latitude, and 87 W longitude.

Guadalupe 45 miles long and 45 broad; in the Atlantic Ocean, famous for ginger, ſugar, and indigo It lies 4200 miles S W from London, in 17 degrees N latitude, and 62 W longitude.

Gullipago, Iſlands; in the ſouth ſea, 400 miles N W of Peru in Am. They lie 7000 miles S W from London, extending from 10 to 15 degrees S latitude, and from 80 to 84 W longitude.

Hiſpaniola, 426 miles long, and 125 broad; in the Atlantic Ocean, E of the gulph of Mexico. It lies 4700 miles S W from London, in 21 degrees N latitude, and 73 W longitude.

Jamaica, 140 miles long, and 60 broad; in the Atlantic Ocean, E of the Bay of Honduras, famous for rum, ſugar, pimento, tamarinds, &c. It lies 4840 miles S W from London, in 17 degrees N latitude, and 79 W longitude.

Japan Iſlands, in the India ocean, famous for japan works, cabinets, lacquered ware, &c. They lie 5800 miles S E. from London, extending from 30 to 40 degrees N latitude, and from 150 to 144 E longitude.

Ladrone Iſlands, in the ſouth ſea; noted for fruit, which, when baked, taſtes like wheat bread. They lie 8000 miles S E from London, extending from 12 to 28 degrees N latitude, and from 142 to 144 E longitude.

Madagaſcar, 1000 miles long and 200 broad, in the ſouthern ocean, 300 miles S E of Africa. It lies 5400 miles S E from London, in 26 degrees S latitude and 51 E longitude.

Madeira Iſlands, in the Atlantic Ocean, 100 miles W of Morocco, famous for wine and ſugar. They lie 1600 miles S W from London, extending from 32 to 33 degrees N latitude, and from 14 to 16 W longitude.

Maldive Iſlands; in the Eaſt India ocean; 500 miles S W of the Malabar coaſt in the Mogul's empire; famous for cocoa. They lie 5200 miles S E from London, extending from 2 degrees S to 7 N latitude, and from 71 to 74 degrees E longitude.

Martinico, 58 miles long and 20 broad; Atlantic Ocean, famous for ſugar, ginger, and indigo, &c. It lies 4200 miles S W from London, in 14 degrees N latitude, and 61 W longitude.

Molucca or Clove Iſlands; in the Eaſt India ocean; famous for cloves and ſago; ſago is the pith of a tree. They lie 7600 miles S E from London, extending from 0 to 2 degrees N latitude, and from 120 to 130 E. longitude.

Newfoundland Iſland; 350 miles long and 200 broad; in the Atlantic Ocean, E of the gulph of St Lawrence; famous for a cod fiſhery on its coaſts. It lies 2300 miles W from London, in 52 degrees N latitude, and 56 W longitude.

Philippian Iſlands (1200 in number) in the Eaſt India ocean, exceeding fruitful in all the neceſſaries of life. They lie 7400 miles S E from London, extending from 5 to 19 degrees N latitude, and from 114 to 131 E longitude.

Solomon's Iſlands (18 in number) in the great ſouth ſea, but little is yet known of them to Europeans. They lie 9000 miles S W from London, extending from 7 to 12 degrees S latitude, and from 130 to 140 W longitude.

Sumatra 1000 miles long, and 100 broad, in the Eaſt India ocean, famous for gold and fine pepper. It lies 6800 miles S E from London, extending from 5 degrees N to 6 S latitude, and from 93 to 104 E longitude.

Sunda Iſlands, in the Eaſt India ocean, famous for gold, pepper, coffee, diamonds, &c. They lie 7300 miles S E from London, extending from 7 degrees N to 8 S latitude, and from 94 to 116 E longitude.

Sokotora or Zocotora Iſlands, in the Indian ocean, famous for frankincenſe, gum-tragacanth, and aloes. They lie 3900 miles S E from London, extending from 12 to 13 degrees N latitude, and from 53 to 54 E longitude.

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